AC 43.13-2A

ACCEPTABLE METHODS, TECHNIQUES, AND PRACTICES

AIRCRAFT ALTERATIONS

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U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

Chapter 6. OXYGEN SYSTEM INSTALLATIONS IN NONPRESSURIZED AIRCRAFT

86. SYSTEM REQUIREMENTS. Install oxygen cylinders conforming to Interstate Commerce Commission requirements for gas cylinders which carry the ICC 3A, 3AA, or 3HT designation followed by the service pressure metal-stamped on the cylinder. The 3HT designated cylinders must not be used for portable oxygen equipment.

a. *Tubing.*

(1) In systems having low pressure (400 p.s.i.), use seamless aluminum alloy or equivalent having an outside diameter of 5/16 inch and a wall thickness of .035″. Double flare the ends to attach to fittings.

(2) In high-pressure systems (1800 p.s.i.), use 3/16 inch O.D., .035″ wall thickness, seamless copper alloy tubing meeting Specification WW–T–779a type N, or stainless steel between the filler valve and the pressure-reducing valve. Silver-solder cone nipples to the ends of the tubing to attach the fittings in accordance with Specification MIL–B–7883.

(3) Use 5/16-inch O.D. aluminum alloy tubing after the pressure-reducer (low-pressure side).

(4) Use flexible connections specifically designed for oxygen between all points having relative or differential motion.

b. *Valves.* A slow opening valve is used as a cylinder shutoff valve, or system shutoff valve. Rapid opening and the subsequent sudden and fast discharge of oxygen into the system can cause dangerous heating which could result in fire or explosion of combustibles within the system.

c. *Regulators.* The cylinder or system pressure is reduced to the individual cabin outlets by means of a pressure-reducing regulator which can be manually or automatically controlled.

d. *Types of Regulators.* The four basic types of oxygen systems, classified according to the type of regulator employed, are:

(1) Demand type.

(2) Diluter-demand type.

(3) Pressure-demand type.

(4) Continuous-flow type.

e. *Flow Indicators.*

(1) A pith-ball flow indicator, vane, wheel anemometer, or lateral pressure indicator which fluctuates with changes in flow or any other satisfactory flow indicator may be used in a continuous flow-type system.

(2) An Air Force-Navy flow indicator or equivalent may be used in a diluter-demand type system. Each flow indicator should give positive indication when oxygen flow is occurring.

f. *Relief Valve.*

(1) A relief valve is installed in low-pressure oxygen systems to safely relieve excessive pressure, such as caused by overcharging.

(2) A relief valve is installed in high-pressure oxygen systems to safely relieve excessive pressure, such as caused by heating.

g. *Gauge.* Provide a pressure gauge to show the amount of oxygen in the cylinder.

h. *Masks.* Only masks designed for the particular system should be used.

87. INSTALLATION.

Oxygen systems present a hazard. Therefore, follow the precautions and practices listed below:

a. Remove oil, grease (including lip salves, hair oil, etc.), and dirt from hands, clothing, and tools before working with oxygen equipment.

b. Prior to cutting the upholstery, check the intended route of the system.

Make sure that all system components are kept completely free of oil or grease during installation and locate components so they will not contact or become contaminated by oil or hydraulic lines.

c. Keep open ends of cleaned and dried tubing capped or plugged at all times, except during attachment or detachment of parts. Do *not* use tape, rags, or paper.

d. Clean all lines and fittings which have not been cleaned and sealed by one of the following methods:

(1) A vapor-degreasing method with stabilized trichlorethylene conforming to Specification MIL-T-7003 or carbon tetrachloride. Blow tubing clean and dry with a stream of clean, dried, water-pumped air, or dry nitrogen (water-vapor content of less than 0.005 milligrams per liter of gas at 70° F and 760 millimeters of mercury pressure).

(2) Flush with naptha conforming to Specification TT-N-95; blow clean and dry of all solvent with water-pumped air; flush with anti-icing fluid conforming to Specification MIL-F5566 or anhydrous ethyl alcohol; rinse thoroughly with fresh water; and dry thoroughly with a stream of clean, dried, water-pumped air, or by heating at a temperature of 250° to 300° F for one-half hour.

(3) Flush with hot inhibited alkaline cleaner until free from oil and grease; rinse thoroughly with fresh water; and dry thoroughly with a stream of clean, dried, water-pumped air, or by heating at a temperature of 250° to 300° F for one-half hour.

e. Install lines, fittings, and equipment above and at least 6 inches away from fuel, oil, and hydraulic systems. Use deflector plates where necessary to keep hydraulic fluids away from the lines, fittings, and equipment.

f. Allow at least a 2-inch clearance between the plumbing and any flexible control cable or other flexible moving parts of the aircraft. Provide at least ½-inch clearance between the plumbing and any rigid control tubes or other rigid moving parts of the aircraft.

g. Allow a 6-inch separation between the plumbing and the flight and engine control cables, and electrical lines. When electrical conduit is used, this separation between the plumbing and conduit may be reduced to 2 inches.

h. Route the oxygen system tubing, fittings, and equipment away from hot ducts and equipment. Insulate or provide space between these items to prevent heating the oxygen system.

i. Mount all plumbing in a manner which prevents vibration and chafing. Support 3/16-inch O.D. copper line each 24 inches and 3/16-inch O.D. aluminum each 36 inches with cushioned loop-type line support clamps (AN-742) or equivalent.

j. Locate the oxygen supply valve (control valve) so as to allow its operation by the pilot during flight. The cylinder shutoff valve may be used as the supply control valve, if it is operable from the pilot's seat. Manifold plug-in type outlets, which are incorporated in automatic systems, may be considered as oxygen supply valves since the pilot can control the flow of oxygen by engaging and disengaging the plug-in type oxygen mask.

NOTE: Locate the oxygen shutoff valve on or as close as practicable to the cylinder to prevent loss of oxygen due to leakage in the system.

88. LOCATION AND MOUNTING. Determine the weight factor and c.g. limits for the installation prior to commencing the installation.

a. Mount the cylinder in the baggage compartment or other suitable location in such a position that the shutoff valve is readily accessible. If possible, provide access to this valve from inside the cabin so that it may be turned on in flight in the event that it was not opened prior to takeoff.

b. Fasten the cylinder brackets securely to the aircraft, preferably to a frame member or floorboard using AN bolts with fiber or similar locking nuts. Add sufficient plates, gussets, stringers, cross-bracing, or other reinforcements, where necessary, to provide a mounting that will withstand the inertia forces stipulated in chapter 1 of this handbook.

c. When cylinders are located where they may be damaged by baggage or stored materials, protect them by a suitable guard or covering.

d. Provide at least ½ inch of clear airspace between any cylinder and a firewall or shroud isolating a designated fire zone.

e. Mount the regulator close to the cylinder to avoid long high-pressure lines.

f. Store the masks in such a way that there will be a minimum delay in removing and putting them into use.

89. THREAD COMPOUND. Use antiseize or thread-sealing compound conforming to Specification MIL-T-5542-B, or equivalent.

a. Do not use compound on aluminum alloy flared tube fittings having straight threads. Proper flaring and tightening should be sufficient to make a flared tube connection leakproof.

b. Treat all male-tapered pipe threads with antiseize and sealing compound (MIL-T-5542-B, or tetrafluroethylene tape MIL-T-27730), or equivalent.

c. Apply the compound in accordance with the manufacturer's recommendation. Make sure that the compounds are carefully and sparingly applied only to male threads, coating the first three threads from the end of the fitting. Do not use compound on the coupling sleeves or on the outside of the tube flares.

90. FUNCTIONAL TEST.

Before inspection plates, cover plates, or upholstering are replaced, make a system check including at least the following:

a. Open cylinder valve slowly and observe the pressure gauge.

b. Open supply valve and remove one of the mask tubes and bayonet fittings from one of the masks in the kit. Plug the bayonet into each of the oxygen outlets. A small flow should be noted from each of the outlets. This can be detected by holding the tube to the lips while the bayonet is plugged into an outlet.

c. Check the complete system for leaks. This can be done with a soap solution made only from a mild (castile) soap or by leak-detector solution supplied by the oxygen equipment manufacturer.

d. If leaks are found, close the cylinder shutoff valve and reduce the pressure in the system by plugging a mask tube into one of the outlets or by carefully loosening one of the connections in the system. When the pressure has been reduced to zero, make the necessary repairs. Repeat the procedure in 90c until no leaks are found in the system.

Caution: Never tighten oxygen system fittings with oxygen pressure applied.

e. Test each outlet for leaks at the point where the mask tube plugs in. This can be done by drawing a soap bubble over each of the outlets. Use the solution sparingly to prevent clogging the outlet by soap. Remove all residue to prevent accumulation of dirt.

f. Examine the system to determine that the flow of oxygen through each outlet is at least equal to the minimum required by the pertinent requirements at all altitudes at which the aircraft is to be operated. This can be accomplished by one of the following methods:

(1) In a continuous flow system when the calibration (inlet pressure vs. flow) of the orifices used at the plug-in outlets is known, the pressure in the low-pressure distribution line can be measured at the point which is subject to the greatest pressure drop. Do this with oxygen flowing from all outlets. The pressure thus measured should indicate a flow equal to or greater than the minimum flow required.

(2) In lieu of the above procedure, the flow of oxygen, through the outlet which is subject to the greatest pressure drop, may be measured with all other outlets open. Gas meters, rotometers, or other suitable means may be used to measure flows.

(3) The measurement of oxygen flow in a continuous flow system which uses a manually adjusted regulator can be accomplished at sea level. However, in a continuous flow system which uses an automatic-type regulator, it may be necessary to check the flow at maximum altitude which will be encountered during the normal operation of the aircraft. The manufacturer of the particular continuous-flow regulator used should be able to furnish data on the operating characteristics of the regulator from which it can be determined whether a flight check is necessary.

(4) The checking of the amount of flow through the various outlets in a diluter-demand or straight-demand system is not necessary since the flow characteristics of the particular regulator being used may be obtained from the manufacturer of the regulator. However, in such systems the availability of oxygen to each regulator should be checked by turning the lever of the diluter-demand regulator to the "100 percent oxygen" position and inhaling through the tube via the mask to determine whether the regulator valve and the flow indicator are operating.

g. Provide one of the following acceptable means or equivalent to indicate oxygen flow to each user by:

(1) Listening for audible indication of oxygen flow.

(2) Watching for inflation of the rebreather or reservoir bag.

(3) Installation of a flow indicator.

91. OPERATING INSTRUCTIONS. Provide instructions appropriate to the type of system and masks installed for the pilot on placards. Include in these instructions a graph or a table which will show the duration of the oxygen supply for the various cylinder pressures and pressure altitudes.

ACTUAL DURATION IN HOURS AT VARIOUS ALTITUDES

Number of Persons	*8000 Ft.*	*10,000 Ft.*	*12,000 Ft.*	*15,000 Ft.*	*20,000 Ft.*
Pilot only	7.6 hr.	7.1 hr.	6.7 hr.	6.35 hr.	5.83 hr.
Pilot and 1 Passenger	5.07 hr.	4.74 hr.	4.47 hr.	4.24 hr.	3.88 hr.
Pilot and 2 Passengers	3.8 hr.	3.55 hr.	3.36 hr.	3.18 hr.	2.92 hr.
Pilot and 3 Passengers	3.04 hr.	2.84 hr.	2.68 hr.	2.54 hr.	2.34 hr.
Pilot and 4 Passengers	2.53 hr.	2.37 hr.	2.24 hr.	2.12 hr.	1.94 hr.

NOTE: The above duration time is based on a fully charged 48 cubic-foot cylinder. For duration using 63 cubic-foot cylinder, multiply any duration by 1.3.

FIGURE 6.1—Typical oxygen duration table.

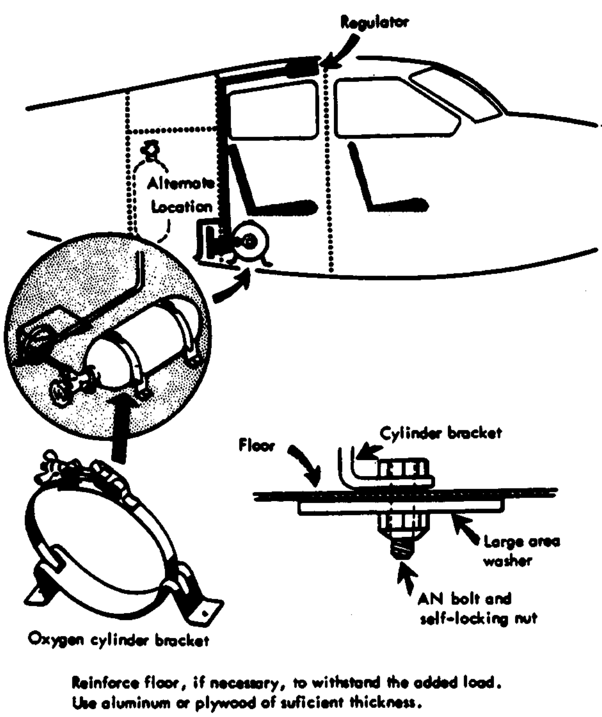

FIGURE 6.2.—Typical floor mounting.

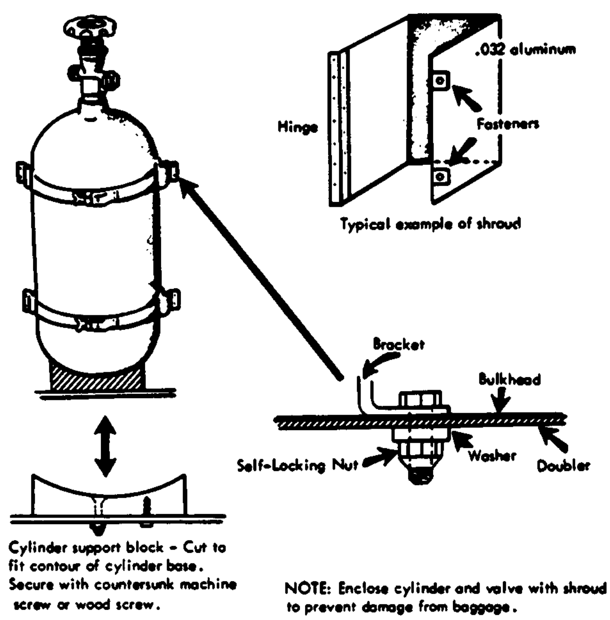

FIGURE 6.3.—Typical baggage compartment mounting.

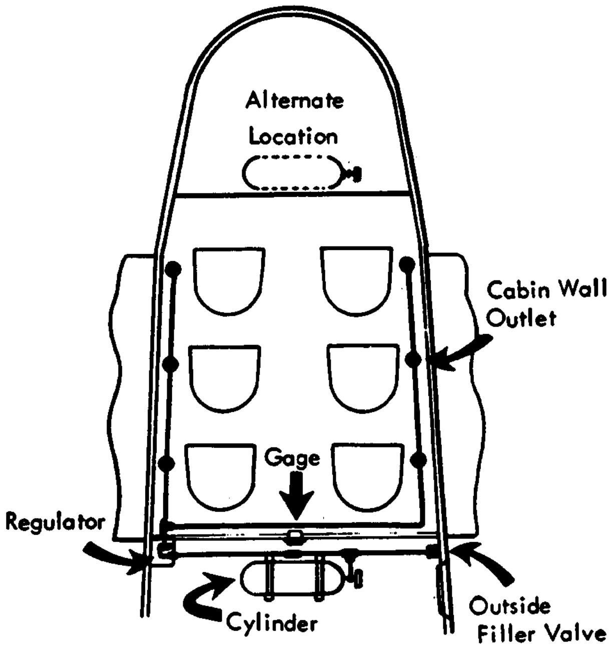

FIGURE 6.4.—Typical oxygen installation in light twin aircraft.

92.-95. [RESERVED]

Chapter 7. ROTORCRAFT EXTERNAL-LOAD DEVICE INSTALLATIONS

Section 1. CARGO SLINGS

96. GENERAL. This section contains structural and design information for the fabrication and installation of a cargo sling used as an external-load attaching means for a Class B rotorcraft-load combination operation under FAR Part 133. As an external-load attaching means, a "cargo sling" includes a quick-release device and the associated cables, fittings, etc., used for the attachment of the cargo sling to the rotorcraft.

97. QUICK-RELEASE DEVICE. Section 133.43(d) of the FARs specifies the requirements for the quick-release device. In addition to commercially manufactured helicopter cargo hooks, some surplus military bomb releases meet the requirements of that section.

98. LOCATION OF CARGO RELEASE IN RELATION TO THE ROTORCRAFT'S C.G. LIMITS.

a. ***An ideal location of the cargo release*** would be one that allows the line of action to pass through the rotorcraft's center of gravity at all times. (See fig. 7.1, illus. A.) However, with

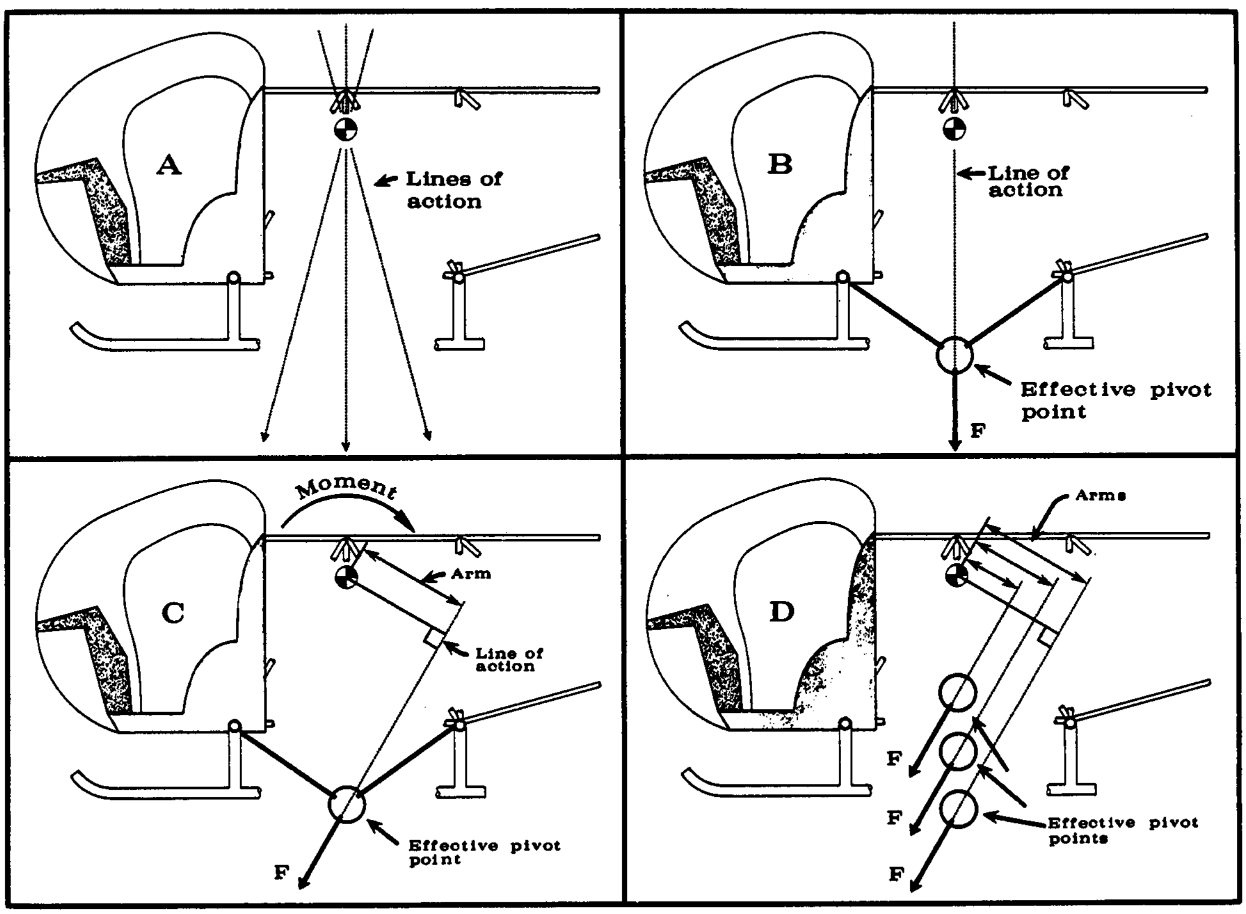

FIGURE 7.1.—Location of cargo release in relation to the rotorcraft's center of gravity.

most cargo sling installations, this ideal situation is realized only when the line of action is vertical or near vertical and through the rotorcraft's c.g. (See fig. 7.1, illus. B.)

b. *Whenever the line of action* does not pass through the rotorcraft's c.g. due to the attachment method used, acceleration forces, or aerodynamic forces, the rotorcraft-load combined center of gravity will shift from the rotorcraft's c.g. position. Depending upon the factors involved, the shift may occur along either or both the longitudinal or lateral axes. The amount of shift is dependent upon the force applied (F) and the length of the arm of the line of action. Their product (F x Arm) yields a moment which can be used to determine the rotorcraft-load combined center of gravity. (See fig. 7. 1, illus. C.) If the rotorcraft-load center of gravity is allowed to shift beyond the rotorcraft's approved center of gravity limits, the rotorcraft may become violently uncontrollable.

c. *Thus, any attachment method or location* which will decrease the length of the arm will reduce the distance that the combined center of gravity will shift for a given load (F) and line of action angle. (See fig. 7.1, illus. D.)

99. MAXIMUM EXTERNAL LOAD. The maximum external load (including the weight of the cargo sling) for which authorization is requested may not exceed the rated capacity of the quick-release device.

100. STATIC TEST. The cargo sling installation must be able to withstand the static load required by FAR 133.43(a). Conduct the test as outlined in Chapter 1 of this advisory circular. If required during the test, supports may be placed at the landing gear to airframe attach fittings to prevent detrimental deformation of the landing gear due to the weight of the aircraft.

101. SLING-LEG ANGLES OF CABLE-SUPPORTED SLINGS. The optimum sling-leg angle (measured from the horizontal) is 45 to 60 degrees. Minimum tension in a sling leg occurs with a sling-leg angle of 90 degrees, and the tension approaches infinity as the angle approaches zero. Thus, larger sling-leg angles are desirable from a standpoint of cable strength requirements. Slings should not be attached in such a manner as to provide sling-leg angles of less than 30 degrees.

102. MINIMUM SLING-LEG CABLE STRENGHT. An analysis which considered the effects of 30-degree sling angles showed that the minimum cable strength design factor required would be 2.5 times the maximum external load for each leg regardless of the number of legs. Although this is the minimum strength required by Part 133, it may be desirable to double this value to allow for deterioration of the sling-leg cables in service. This will result in a cable strength equal to 5 times the maximum external load.

Example: Maximum external load 850 pounds
Minimum required sling-leg cable strength 850 x 2.5=2125
Minimum desired sling-leg cable strength 850 x 2.5 x 2=4250

A 3/16-inch, nonflexible 19-wire cable (MIL-W-6940) provides a satisfactory cable strength. See figure 4.1, chapter 4, of AC 43.13-1A for a table of breaking strength of steel cable. For convenience, the cable sizes desired for various loads have been calculated and are tabulated in figure 7.2 based on a factor of 5:

Maximum External Load (pounds)	*Aircraft Cable Size For Each Cargo Sling Leg*		
	MIL-C-5693 and MIL-W-6940	*MIL-W-1511*	*MIL-C-5424*
100	1/16	3/32	3/32
200	3/32	1/8	1/8
300	7/64	1/8	1/8
400	1/8	1/8	5/32
500	5/32	5/32	3/16
600	5/32	3/16	3/16
700	3/16	3/16	3/16
800	3/16	3/16	7/32
900	3/16	7/32	7/32
1,000	7/32	7/32	7/32
1,200	7/32	1/4	1/4
1,400	1/4	1/4	9/32
1,600	1/4	9/32	5/16
1,800	5/16	5/16	5/16
2,000	5/16	11/32	3/8

FIGURE 7.2.—Cable Load Table.

103. SLING INSTALLATION. Attach the cargo sling to landing gear members or other structure capable of supporting the loads to be carried. Install the quick-release device in a level attitude with the throat opening facing the direction as indicated on the quick-release device. When cables are used to support the quick-release device, make sure the cables are not twisted or allowed to twist in the direction to unlay the cable.

Some cargo release devices are provided with a fitting to permit installation of a guideline to assist in fully automatic engagement of the load target ring or load bridle. Secure the guideline to the quick-release device with a shear pin of a definite known value which will shear if a load becomes entangled on or over the guideline. Provision should also be made for cable-supported slings to be drawn up against the fuselage into a stowage position to prevent striking or dragging the release on the ground when not in use.

104. INSTALLATION OF RELEASE CONTROLS. See figure 7.3 for typical wiring diagram of the electrical controls.

a. ***Install a cargo release master switch,*** readily accessible to the pilot, to provide a means of deactivating the release circuit. The power for the electrical release circuit should originate at the primary bus. The "auto" position of the release master switch on some cargo release units provides for automatic release when the load contacts the ground and the load on the release is reduced to a preset value.

b. ***Install the cargo release switch*** on one of the pilot's primary controls. It is usually installed on the cyclic stick to allow the pilot to release the load with minimum distraction after maneuvering the load into the release position.

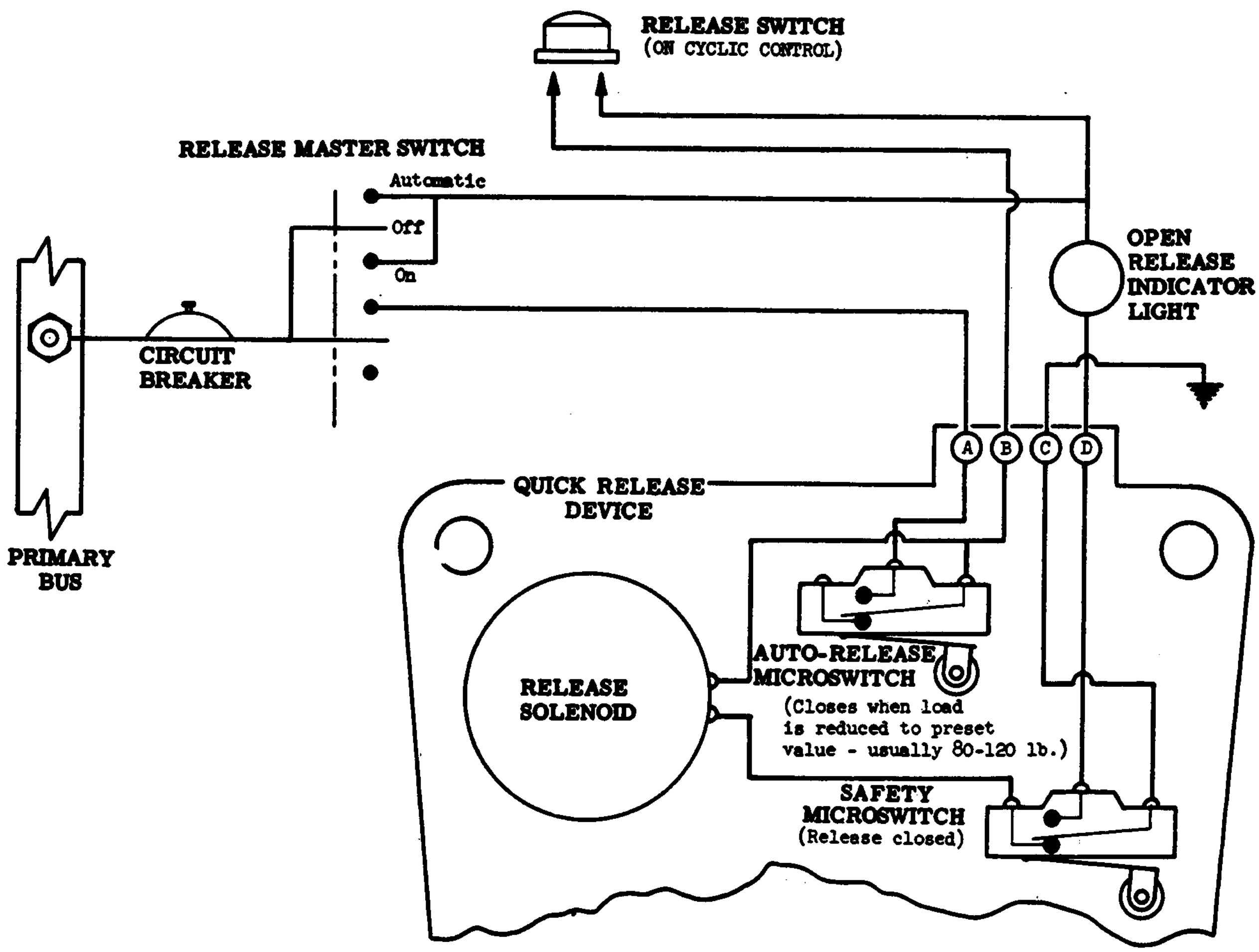

FIGURE 7.3.—Typical cargo sling wiring diagram.

c. ***Install the emergency manual release control*** in a suitable position that is readily accessible to the pilot or other crewmember. Allow sufficient slack in the control cable to permit complete cargo movement without tripping the cargo release.

d. ***The manual ground release handle,*** a feature of some cargo release units, permits opening of the cargo release by ground personnel.

e. ***Label or placard*** all release controls as to function and operation.

105. FUNCTIONAL TEST. Test the release action of each release control of the quick-release device with various loads up to and including the maximum external load. This may be done in a test fixture or while installed on the rotorcraft, if the necessary load can be applied.

If the quick-release device incorporates an automatic release, the unit should not release the load when the master switch is placed in the "automatic" position until the load on the device is reduced to the preset value, usually 80 to 120 pounds.

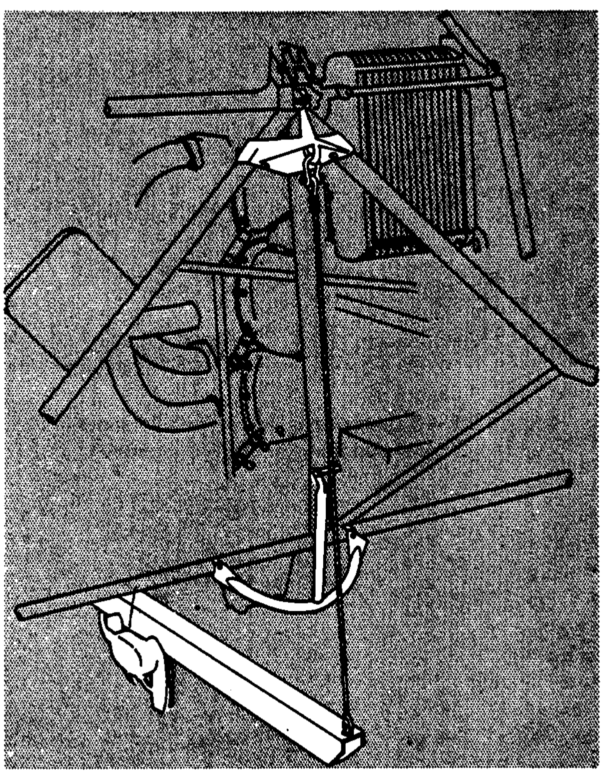

FIGURE 7.4.—Typical cargo sling installation No. 1.

106. SUPPLEMENTAL FLIGHT INFORMATION. The aircraft may not be used in Part 133 external-load operations until a Rotorcraft-Load Combination Flight Manual is prepared in accordance with section 133.47 of that Part.

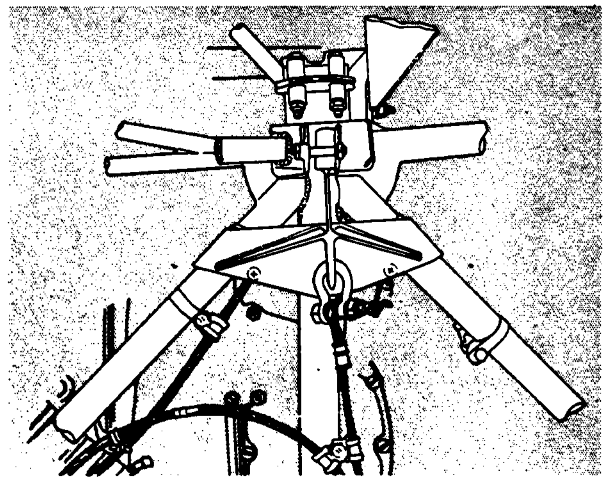

FIGURE 7.5.—Typical cargo sling installation No. 1 (showing fuselage attachment fitting).

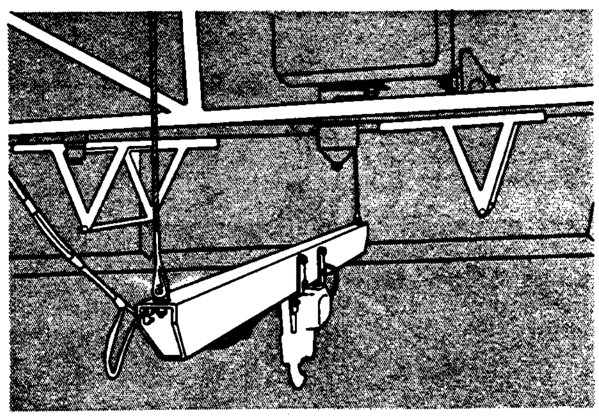

FIGURE 7.6—Typical cargo sling installation No. 1 (showing fore and aft limiting stops).

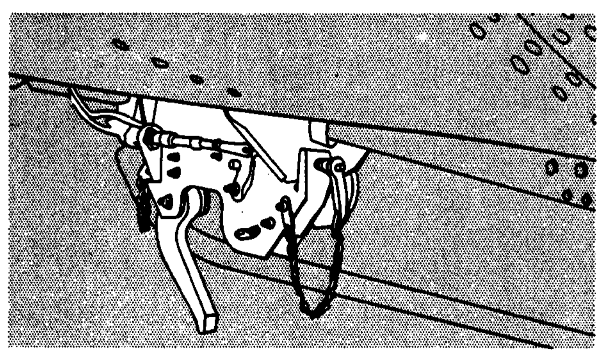

FIGURE 7.7.—Typical cargo sling installation No. 2 (cargo hook attached directly to underside of fuselage).

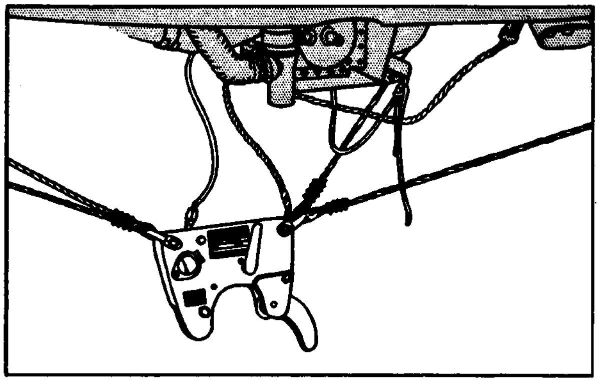

FIGURE 7.8.—Typical cargo sling installation No. 3 (4-leg, cable suspended).

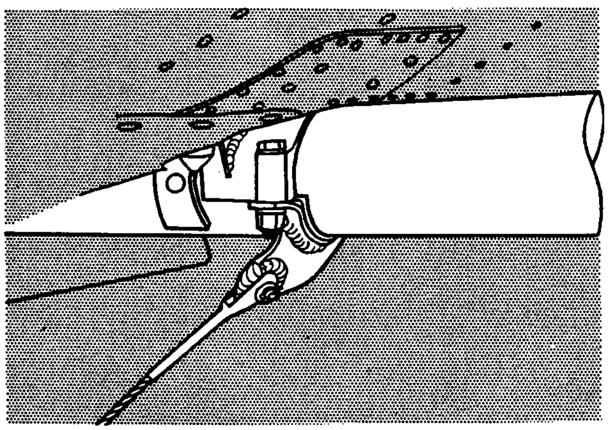

FIGURE 7.9.—Typical cargo sling installation No. 3 (showing cable sling leg attachment to landing gear cross-tube fitting).

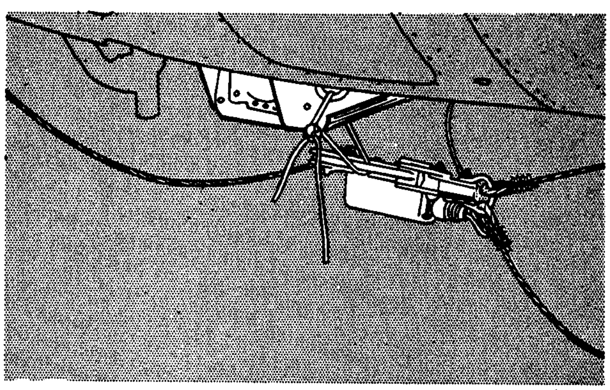

FIGURE 7.10.—Typical cargo sling installation No. 3 (showing cargo sling in stowed position).

107.-110. [RESERVED]

Section 2. CARGO RACKS

111. GENERAL. This section contains structural and design information for the fabrication and installation of a cargo rack used as an external-load attaching means for a Class A rotorcraft-load combination operation under FAR Part 133.

112. FABRICATION OF CARGO RACKS. The type of construction and method of attachment depend upon the material to be used and the configuration of the rotorcraft involved. Illustrations of typical construction and installation methods are shown in fiigures 7.11–7.15.

113. STATIC TEST. The cargo rack installation must be able to withstand the static test load required by FAR 133.43(a). Conduct the test as outlined in chapter 1 of this handbook.

114. SUPPLEMENTAL FLIGHT INFORMATION. The aircraft may not be used in Part 133 external-load operations until a rotorcraft-load combination flight manual is prepared in accordance with section 133.47 of that Part.

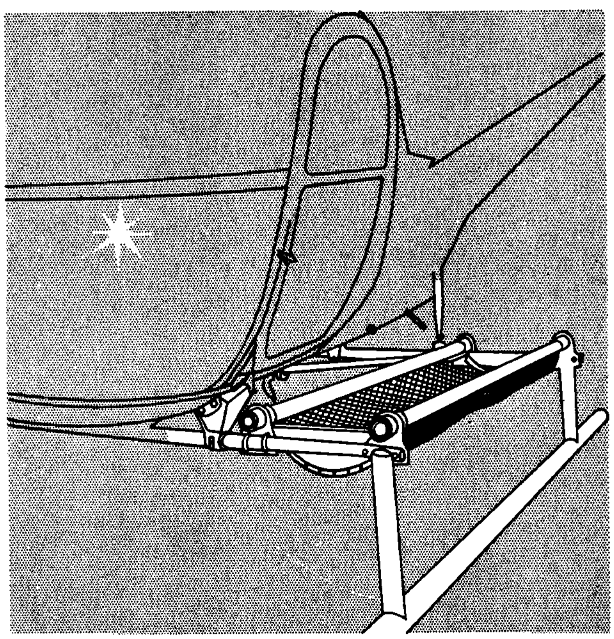

FIGURE 7.11.—Typical cargo rack installation No. 1.

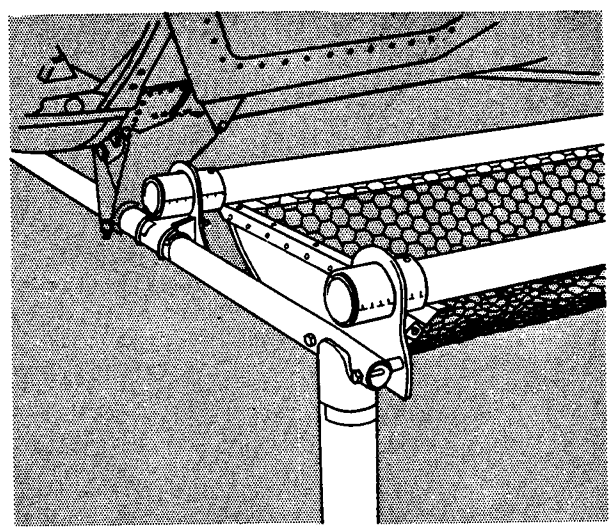

FIGURE 7.12.—Typical cargo rack installation No. 1 (showing attachment detail).

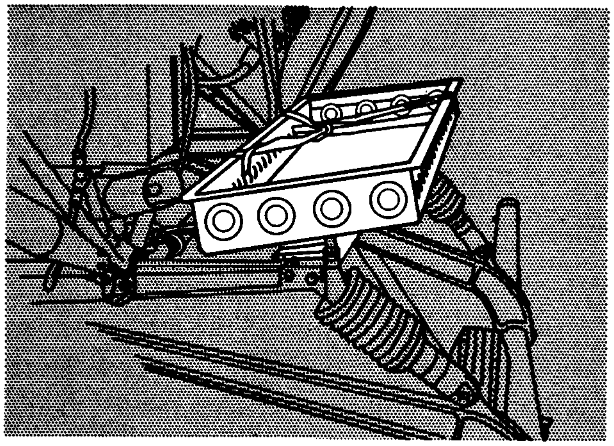

FIGURE 7.13.—Typical cargo rack installation No. 2.

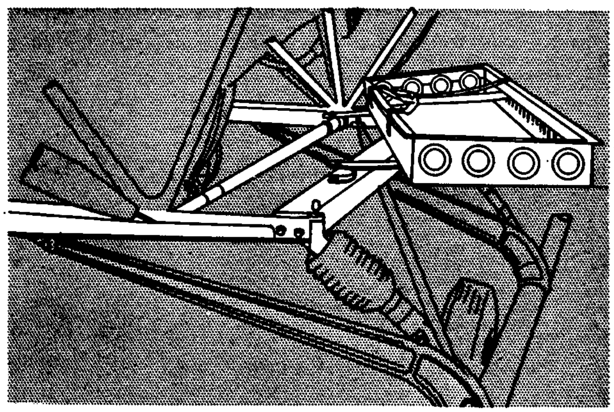

FIGURE 7.14.—Typical cargo rack installation No. 2 (showing rack partially installed).

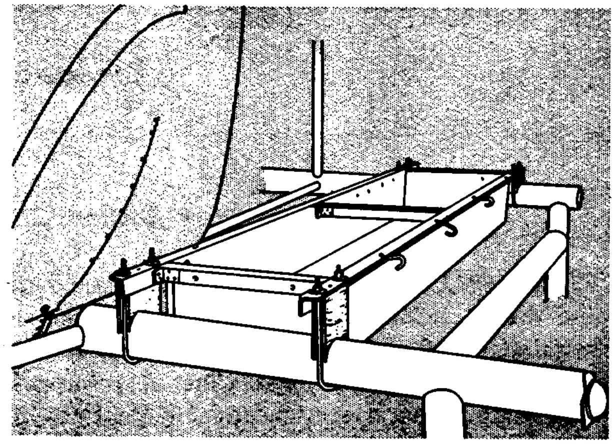

FIGURE 7.15.—Typical cargo rack installation No. 3.

115.–120. [RESERVED]

Chapter 8. GLIDER AND BANNER TOW-HITCH INSTALLATIONS

Section 1. TOWPLANE CONSIDERATIONS

[Deleted] Change 1

Section 2. TOW-HITCH INSTALLATIONS

126. STRUCTURAL REQUIREMENTS. The structural integrity of a tow-hitch installation on an aircraft is dependent upon its intended usage. Hitches which meet the glider tow criteria of this chapter are acceptable for banner tow usage. However, because the direction and magnitude of maximum dynamic banner towline loads occur within a more limited rearward cone of displacement than do glider towline loads, hitches which meet the banner tow criteria of this chapter may not be satisfactory for glider towing. Due to the basic aerodynamic difference between the two objects being towed, glider and banner tow-hitch installations are treated separately with regard to loading angles.

* ***a. Glider tow hitches.*** Protection for the towplane is provided by requiring use of a towline assembly which will break prior to structural damage occurring to the towplane. The normal tow load of a glider rarely exceeds 80 percent of the weight of the glider. Therefore, the towline assembly design load for a 1,000-pound glider could be estimated at 800 pounds. By multiplying the estimated design load by 1.5 (to provide a safety margin), we arrive at a limit load value of 1,200 pounds. The 1,200-pound limit load value is used in static testing or analysis procedures per paragraph 127 of this handbook to prove the strength of the tow hook installation. When the hook and structure have been proven to withstand *

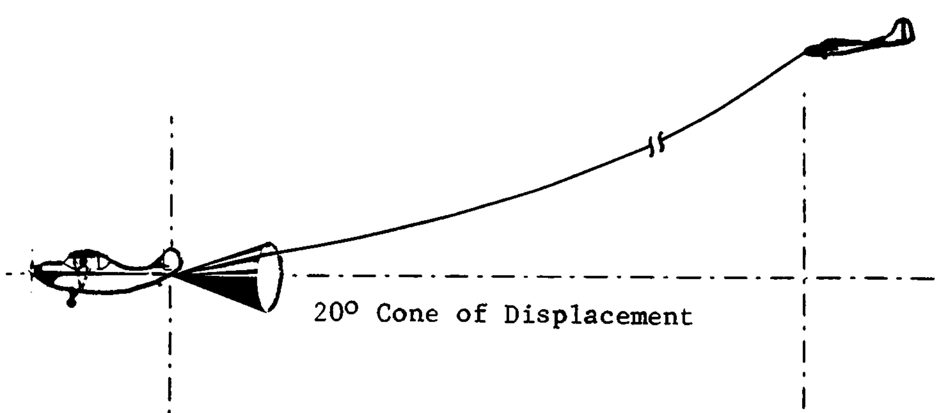

FIGURE 8.1.—Glider tow angle.

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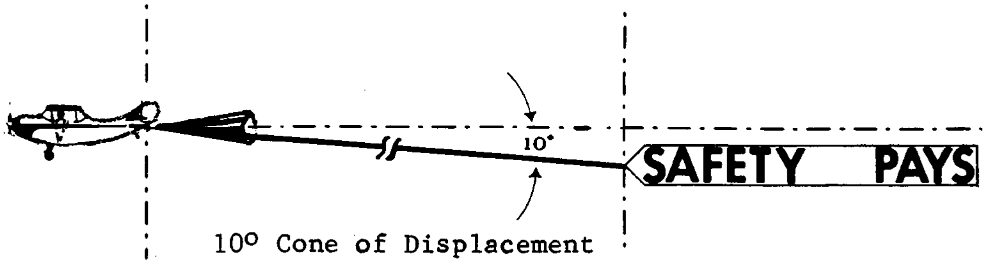

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FIGURE 8.2.—Banner tow angle.

*the limit load, then the *maximum* breaking strength of the towline assembly is established at the design load of 800 pounds. Thus, the towline will break well before structural damage will occur to the towplane.

Another approach can be applied if the limit load carrying capabilities of a tow hook and fuselage are known. In this case, the known load value can be divided by 1.5 to arrive at the design load capabilities if the tow hook and fuselage limit loads are known to be 1,800 pounds. By dividing by 1.5 (1800 ÷ 1.5 = 1,200) we arrive at a design load value of 1,200 pounds. Thus, the maximum breaking strength of the towline assembly is established at 1,200 pounds and provides protection for the towplane.

Thus, in considering tow hook installations, one may establish maximum towline breaking strength by:

(1) Dividing the known limit load capabilities of the fuselage and two hook installation by 1.5; or

(2) Knowing the design load needs of the towline assembly and multiplying by 1.5 to arrive at a limit load. Then by analysis or static testing, determine that the hook and fuselage are capable of withstanding that limit load.

b. ***Banner tow hitches.*** Install the hitch to support a limit load equal to at least two times the operating weight of the banner.

127. STRUCTURAL TESTING. Adequacy of the aircraft structure to withstand the required loads can be determined by either static test or structural analysis.

a. ***Static testing.*** When using static tests to verify structural strength, subject the tow hitch to the limit load (per paragraph 126 a or b) in a rearward direction within the appropriate cone of displacement per figure 8.2. Testing to be done in accordance with the procedures of Chapter 1, paragraph 3, of this handbook.

b. ***Structural analysis.*** If the local fuselage structure is not substantiated by static test for the proposed tow load, using a method that experience has shown to be reliable, subject the fuselage to engineering analysis to determine that the local structure is adequate. Use a fitting factor of 1.15 or greater in the loads for this analysis.

128. ATTACHMENT POINTS. Tow-hitch mechanisms are characteristically attached to, or at, tiedown points or tailwheel brackets on the airframe where the inherent load-bearing qualities can be adapted to towing loads. Keep the length of the hitch-assembly arm from the airframe attachment point to the tow hook to a minimum as the loads on the attachment bolts are multiplied by increases in the moment arm.

129. ANGLES OF TOW. Tests should be conducted on the system at various tow angles to insure that:

a. There is no interference with the tailwheel or adjacent structure.

b. The towline clears all fixed and movable surfaces at the maximum cone of displacement and full surface travel.

c. The mechanism does not significantly decrease the clearance from the tailwheel to the rudder.

d. The tow hitch does not swivel. Experience has shown swiveling could result in fouling both the release line and towline during operations by the towplane.

e. The opened jaw of the hitch does not strike any portion of the aircraft.

130. PLACARDS. A placard should be installed in a conspicuous place in the cockpit to notify the pilot of the structural design limits of the tow system.

The following are examples of placards to be installed:

a. For glider tow—"Glider towline assembly breaking strength not to exceed ______*______ pounds."

b. For banner tow—"Tow hitch limited to banner maximum weight of ______**______ pounds."

* Value established per paragraph 126 a (1) pr (2).

** Banner hitch limitations are one-half the load applied per paragraph 126 b.

131. WEIGHT AND BALANCE. In most cases, the weight of the tow-hitch assembly will affect the fully loaded aft c.g. location. To assure that the possibility of an adverse effect caused by the installation has not been ignored, enter all pertinent computations in the aircraft weight & balance records. (In accordance with the provisions contained in FAR 43.5(a) (4).)

132. TOW RELEASE MECHANISM.

a. ***Release lever.*** A placard indicating the direction of operation should be installed to allay the possibility of confusion or inadvertant opera-*

* tion, and the design of the release lever should provide the following:

(1) Convenience in operation.

(2) Smooth and positive release operation.

(3) Positioned so as to permit the pilot to exert a straight pull on the release handle.

(4) Sufficient handle travel to allow for normal slack and stretch of the release cable.

(5) A sufficient handle/lever ration to assure adequate release force when the towline is under high loads. (See fig. 8.3)

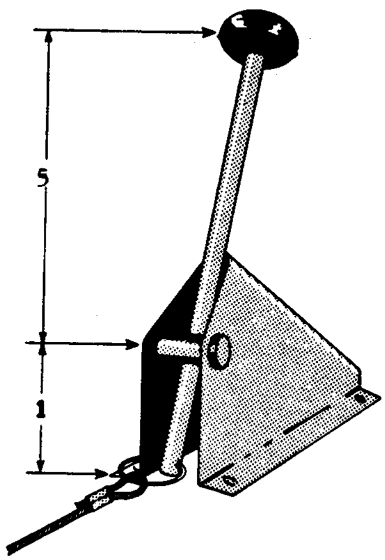


FIGURE 8.3—Typical tow-hitch release handle.

(6) Protection of cables from hazards such as:

(a) Wear and abrasion during normal operation.

(b) Binding where cables pass through fairleads, pulleys, etc.

(c) Accidental release.

(d) Interference by other aircraft components.

(e) Freezing and moisture accumulation when fixed or flexible tubing guides are used.

b. *Test of the release.* A test of the release and hook for proper operation through all angles of critical loading should be made using the design load for the glider or banner.

c. *Release cable.* Representative size and strength characteristics of steel release cable are as shown in figure 8.4; however, it is recommended that all internally installed release cables be 1/16-inch or larger.

Diameter inches	*Nonflexible Carbon Steel 1 x 7 and 1 x 19 (MIL-W-6904B)*		*Flexible Carbon Steel 7 x 7 and 7 x 19 (MIL-W-1511A and MIL-C-5424A)*	
	Breaking strength (lbs.)	*Pounds 100 ft.*	*Breaking strength (lbs.)*	*Pounds 100 ft.*
1/32	185	.25	—	—
3/64	375	.55	—	—
1/16	500	.85	480	.75
5/64	800	1.40	—	—
3/32	1,200	2.00	920	1.60

FIGURE 8.4.—Representative steel cable qualities.

133. [Deleted] Change 1.

FIGURE 8.5.— [Deleted] Change 1. *

operating weight of the glider, install two weak links as follows:

(1) At the glider end with a strength of not less than 80% and not more than twice the glider operating weight.

(2) At the towplane end with a strength greater but not more than 25% greater than the link at the glider end and not more than twice the glider operating weight (ref. paragraph 126a).

b. *Service life.* The practical life of a manila towline is usually limited to 1 year. After this period of service the line cannot be relied upon, even though it may still look good. Conversely, nylon, polypropylene or polyethylene towlines do not have an age limit, provided the fibers are not broken or frayed.

c. *Construction.* A steel tow ring should be used at each end of the towline. A welded ring having an approximate outside diameter of 2″ and made from ¼″ round 4130 steel stock is satisfactory, if properly fabricated. Inspect completed rings in accordance with the procedures contained in chapter 7 of AC 43.13–1A, "Acceptable Methods, Techniques, and Practices—Aircraft Inspection and Repair." Use a thimble to prevent the towline from wearing against the ring. Splices, when necessary or desirable, will preserve approximately 90% of the line strength. On manila ropes use five "tucks" in an eye splice, for nylon ropes use six "tucks" because the fibers are slippery. Splices may be made more secure, and the rope around the thimble can be made to last longer if the splice is wrapped with plastic tape.

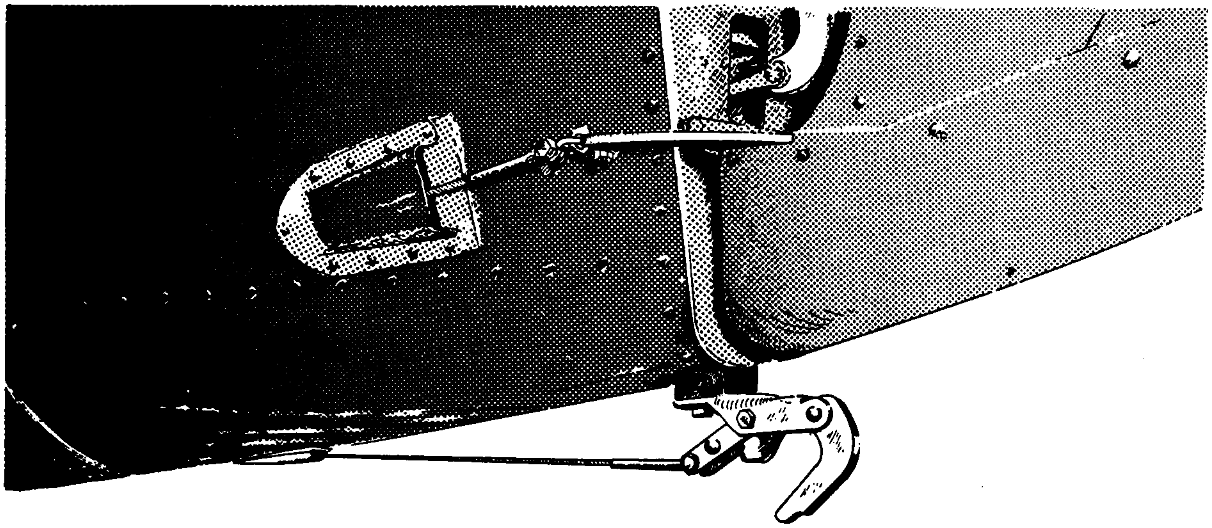


FIGURE 8.6.—Tricycle gear aircraft.

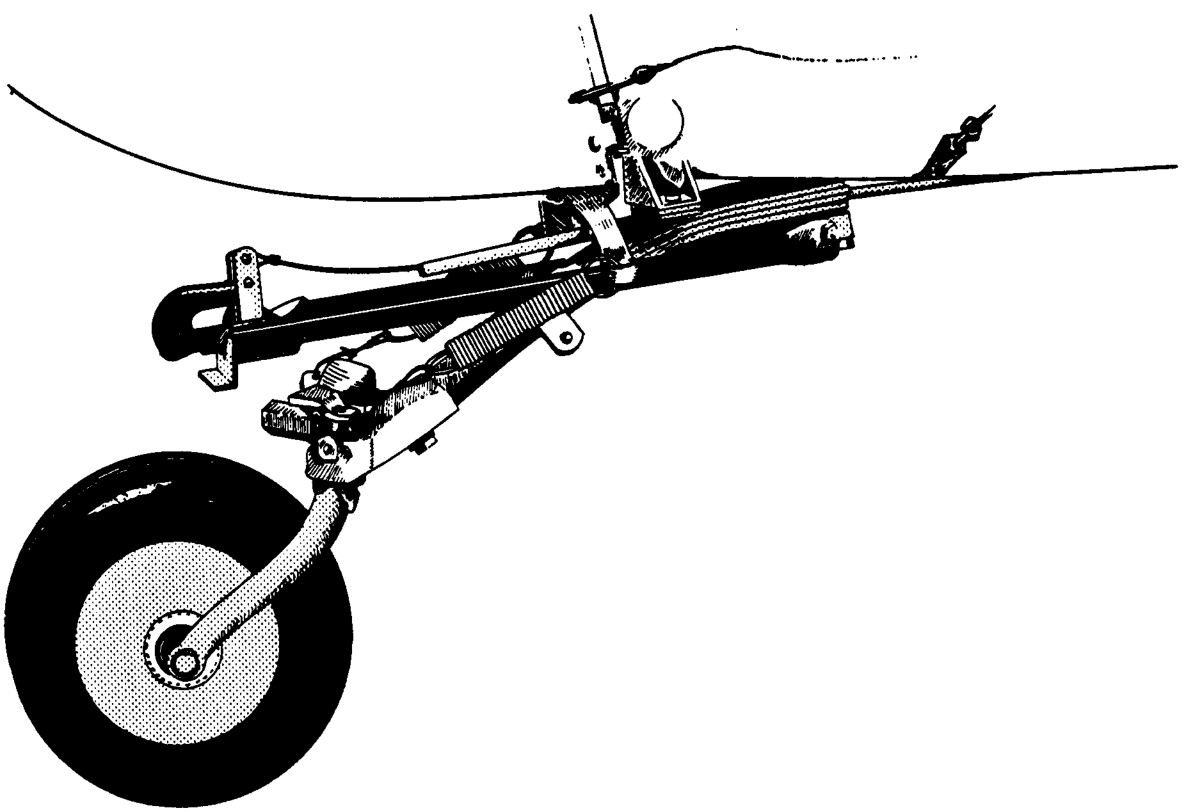


FIGURE 8.7.—Conventional gear aircraft—leaf spring type tailwheel.

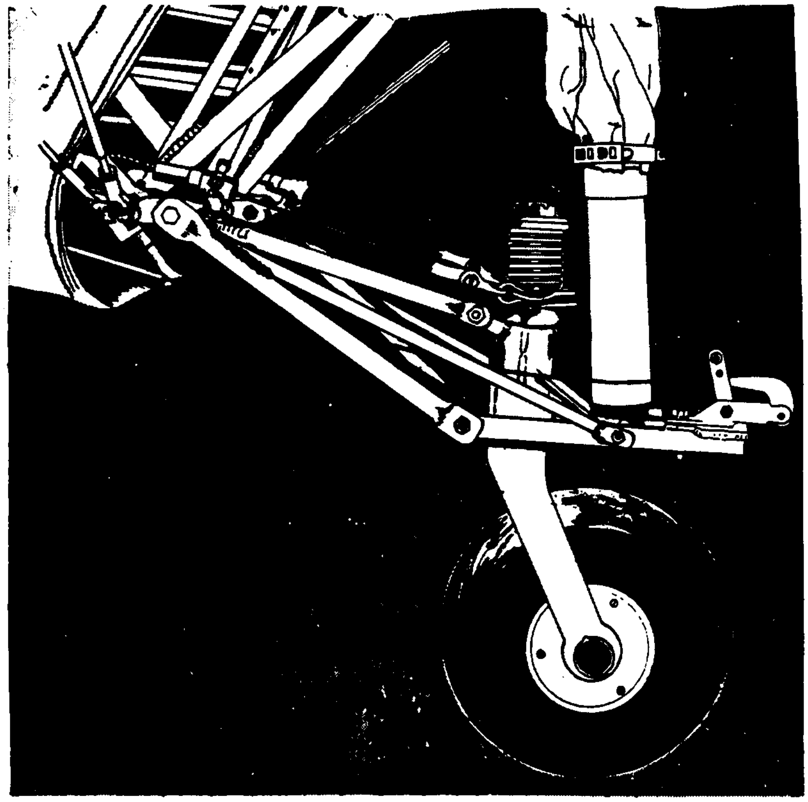


FIGURE 8.8.—Conventional gear aircraft—shock strut type tailwheel.

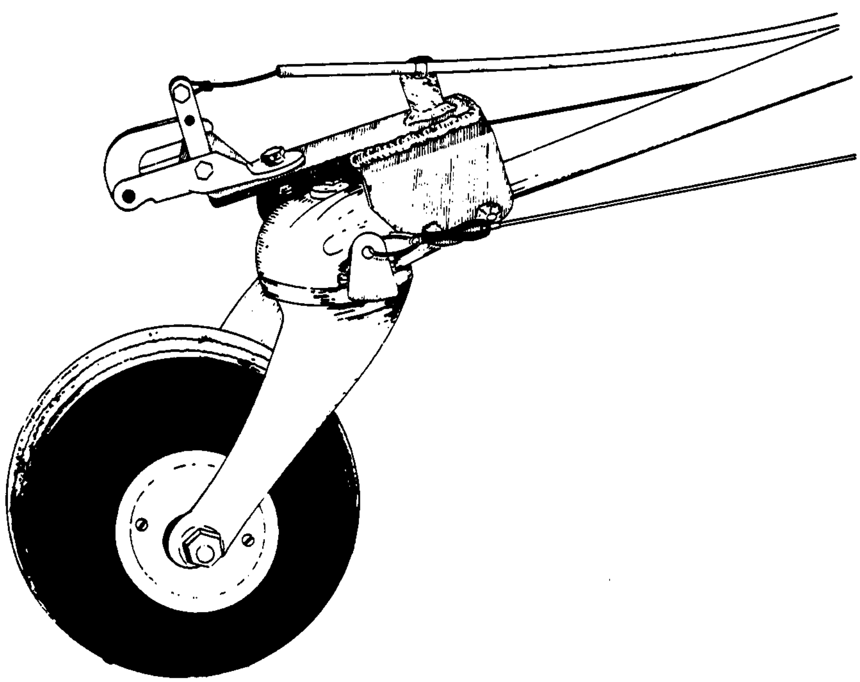


FIGURE 8.9.—Conventional gear aircraft—tubular spring type tailwheel.

134.-145. [RESERVED]

Chapter 9. SHOULDER HARNESS INSTALLATIONS

Section 1. RESTRAINT SYSTEMS

146. GENERAL. The primary objective in shoulder harness design is to prevent incapacitating and/or fatal injuries to personnel involved in a survivable crash condition in which the aircraft cabin structure remained reasonably intact. Any harness configuration which achieves this objective is satisfactory from a safety viewpoint, regardless of the type of harness and mounting position used.

Basic requirements of the aircraft airworthiness rules are designed to provide an aircraft structure to give each occupant a reasonable chance of escaping serious injury in a crash landing. These requirements adequately provide for conditions that can be expected to occur in various types of survivable accidents.

The human body has the inherent capability of withstanding decelerations of 20g's for time periods of up to 200 milliseconds (.2 second) without injury. Experience with aircraft used in agricultural and military operations shows that even in such unusual operations a high rate of survival in crashes is achieved when a restraint system is designed on the order of 20g to 25g deceleration loads.

In view of the foregoing, persons installing a shoulder harness may wish to use a restraint system designed to withstand 20g to 25g loads. In addition, seat belts and seat belt anchorages designed to these load limits may be used.

147. TYPES OF RESTRAINT SYSTEMS. There are two generalized types of shoulder harnesses currently in use. They are the single diagonal type harness and the double over-the-shoulder type harness. The over-the-shoulder harness may utilize either two independent attach points, or join in a "Y" configuration and attach at a single point. (See figs. 9.1 and 9.2) In all cases, however, the original safety belt or a combination harness utilizing a lap belt must be used in the installation.

148. ADVANTAGES OF DIFFERENT HARNESS TYPES. The single diagonal chest strap in combination with a lap belt is the simplest harness system and works effectively for longitudinal decelerations. However, during side decelerations, an occupant in this type harness has a tendency to slip out and away from the chest strap even when it fits snugly. The double over-the-shoulder type harness works well for both longitudinal and side decelerations.

149. MOUNTING CONFIGURATIONS. The type of shoulder restraint configuration acceptable for installation is dependent upon the attachments available in each individual aircraft. Basic harness mounting configurations are:

a. Seat mounted.

b. Airframe mounted.

(1) Side

(2) Ceiling

(3) Floor

(4) Directly rearward

150. STANDARDS. At the present time, there is a lack of standards for materials acceptable for use in shoulder harnesses. Until such time as a TSO is developed for shoulder harnesses, standards established in TSO-C22f pertaining to the materials and testing of safety belts may be accepted for this purpose.

151. MATERIALS.

a. *Webbing*. Synthetic materials, such as nylon and dacron, may be used for shoulder harness webbing. It is recommended that the webbing of the shoulder harness be the same as that of the lap belt to avoid problems in cleaning, staggered replacement of harness components due to wear or age, etc.

b. *Fittings.* Use hardware that:

(1) Conforms to an acceptable standard such as AN, NAS, TSO, or MIL-SPEC.

(2) Meets the strength required by FAR 23.1413 or 25.1413, as appropriate.

(3) Will not loosen in service due to vibration or rotational loads.

C. *Inertia Reels.* The function of the inertia reel is to lock and restrain the occupant in a crash yet provide the ability for normal movement without restrictions. In addition, automatic rewinding of any slack assures that the harness is always snug, which results in a more comfortable restraint system.

Self-contained inertia reel units may be mounted at readily accessible locations and will generally operate effectively in any attitude. Their use in a body restraint system is satisfactory if mounted in accordance with acceptable methods, techniques, and practices, and will meet static strength requirements equal to those outlined in FAR 23.1413.

Check the reel itself for the following operational hazards:

(1) Inadvertent Lockup. If the inertia mechanism is set at a low "g" setting, unwanted lockup, or binding, of the system may occur. A reel lockup range between .9 and 2.5 "g" is acceptable.

(2) *Improper Webbing Length.* Install adequate webbing on the takeup reel to allow the occupant to reach all necessary switches and controls in the cockpit. Any additional webbing will result in decreasing the reel spring "takeup" tension exerted on the shoulder.

(3) *Incorrect Belt Opening Alignment.* Position the reel so that the belt opening is aligned in the direction of loading. This will prevent the belt from rubbing and fraying due to normal usage.

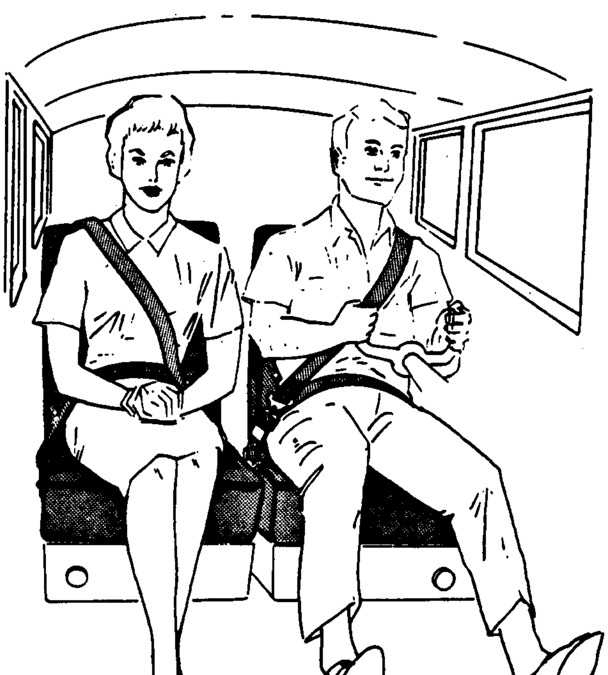


FIGURE 9.1.—Single diagonal type harness.

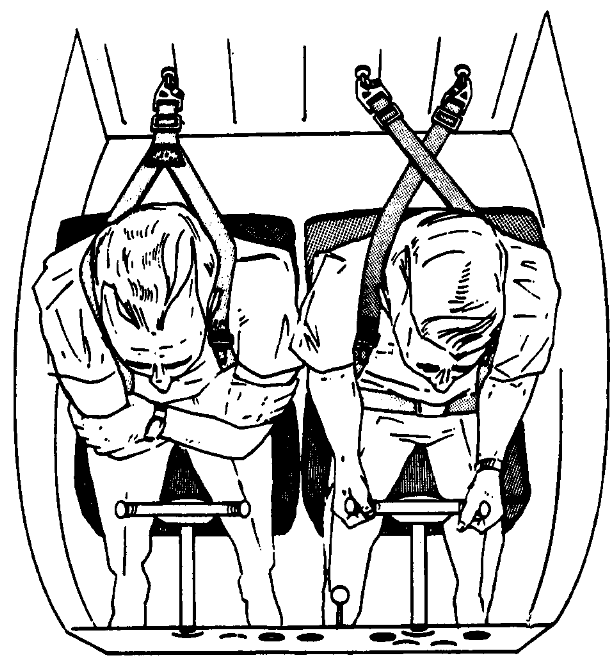


FIGURE 9.2.—Double over-the-shoulder type harness.

152.–155. [RESERVED]

Section 2. EFFECTIVE RESTRAINT ANGLES

156. RELATIONSHIP OF THE HARNESS ASSEMBLY TO THE OCCUPANT. Most restraint systems are designed so that each belt section maintains a certain relationship to the body. The attachment end of a restraint belt must maintain a relative angle and spacing to the head and neck surfaces as it passes over the shoulder and away from the body. This angle must provide sufficient freedom to assure normal body movements of the seated occupant without neck contact or interfering with vision.

157. ATTACHMENT AREAS FOR SHOULDER HARNESS. Effective attachment areas for the various types of shoulder harnesses are defined as angles formed by the attachment ends. Assure that when installing a harness for one seat that in a crash, a passenger to the rear would not sustain head impact injuries on the harness or its attach point.

a. Single Diagonal Type Harness. The optimum rearward attachment area for this type of harness is within an angle of 30 degrees above the horizontal measured from the midpoint on the occupant's shoulder as shown in figures 9.3 and 9.4.

Belt attachments should be located to the rear and outboard of the shoulder. This mounting area is shown in figure 9.5.

(1) Attachment points inboard of this area would permit the harness to impinge on the neck and could result in neck injury during crash impact. In addition, the constant rubbing of the strap on the neck would be uncomfortable and, as a result, act as a distraction to the safe operation of the aircraft. Attachment points forward of this area would reduce the effectiveness of the harness, due to a lack of contact between the harness and the upper torso of the occupant. In addition, a shoulder strap attached forward of

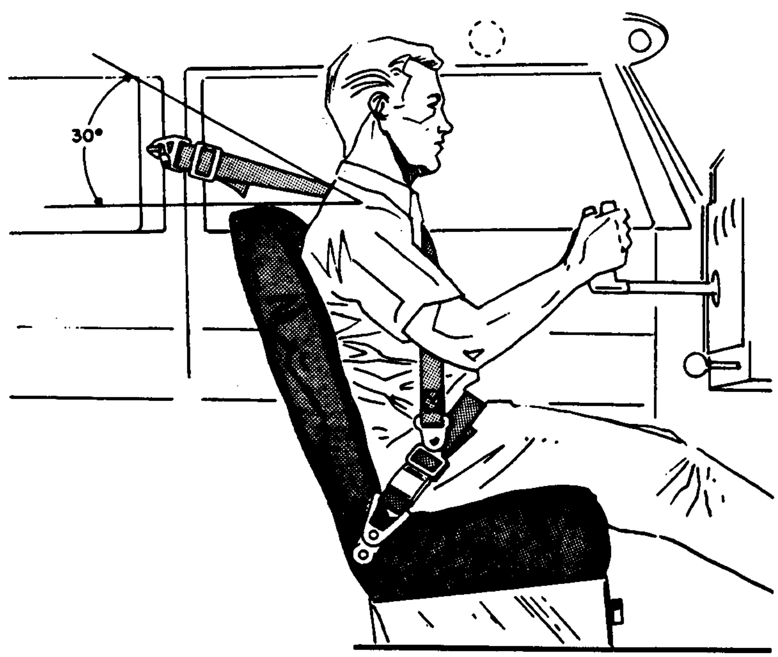


FIGURE 9.3.—Side mounted—single diagonal type harness.

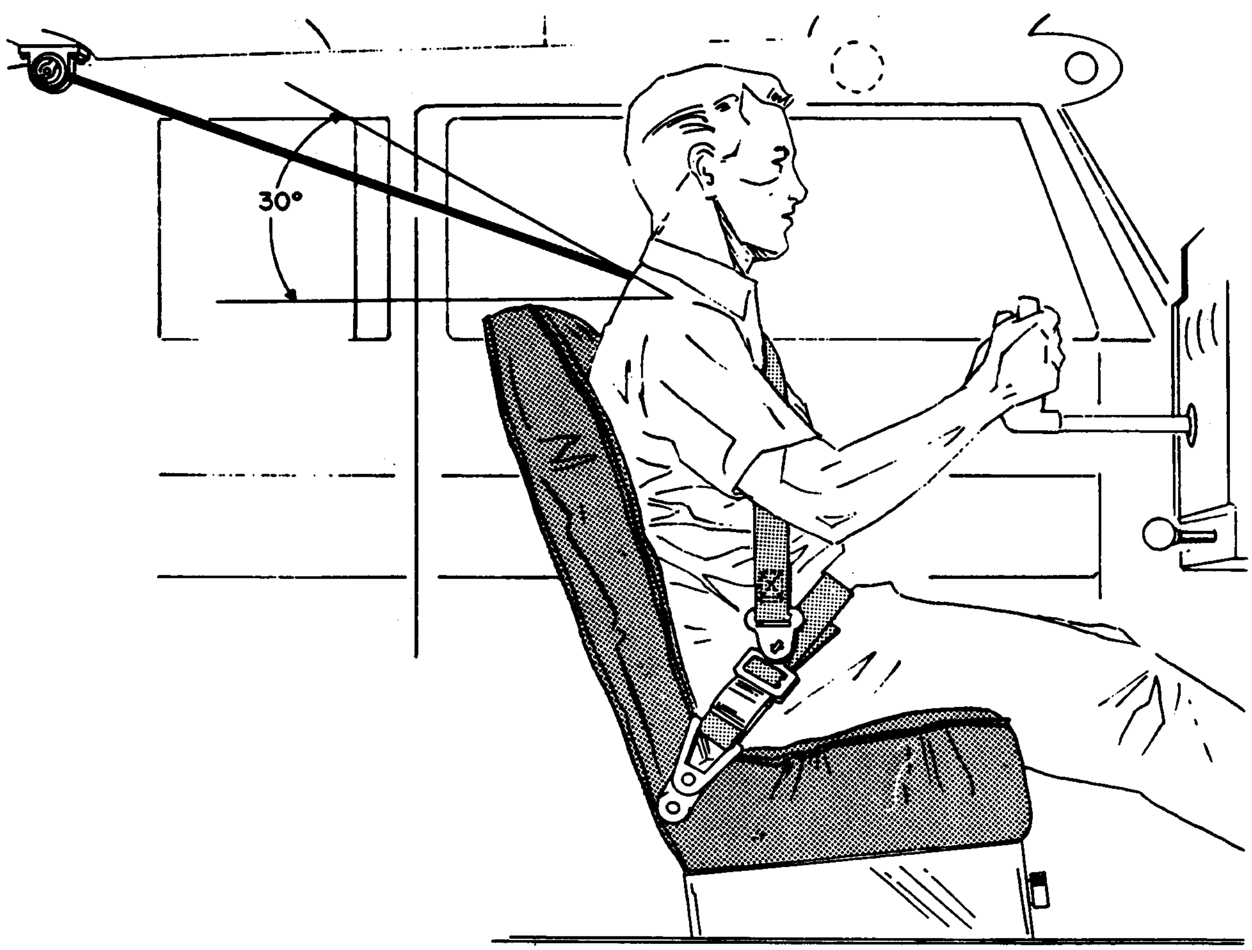


FIGURE 9.4.—Ceiling mounted inertia reel—single diagonal type harness.

the shoulder midpoint could obstruct vision and create a potential safety hazard.

(2) The harness should be kept snug as any decrease in the distance between the occupant's head and the forward cabin structure increases the opportunities for head impact injuries. Also, the chances for twisting out of the harness are significantly increased.

b. ***Double Over-the-Shoulder Type Harness.*** If this type of harness is intended to be mounted either directly rearward or to the ceiling, mount it within the 30-degree vertical angle as shown in figure 9.6.

Because of the limited number of rearward shoulder harness attachment points in many aircraft, a 5-degree angle below the horizontal is also considered acceptable.

Shoulder harness attach areas as viewed from above are shown in figure 9.7. These mounting areas may be used for either the independent or the "Y" type belts. The outboard limit is established to prevent the belt section from slipping off the shoulder, and the maximum inboard angle is limited to a point which will prevent impingement on the neck surface.

158. AREA AND ANGLE DEVIATIONS. While the areas and angles given in the above paragraphs are intended to assist in the selection of attachment points, they should be considered as the optimum and not be interpreted as being mandatory. Area and/or angle deviations could result in a decrease in the overall efficiency of the restraint system; however, they may be necessary in order to permit a harness installation in an aircraft which otherwise could not be accomplished. It is probable that other compromises may be necessary when adapting a specific restraint system to an aircraft in order to fit a body of average dimensions. These compromises, however, should be permitted only when they are compatible with proper restraint functions.

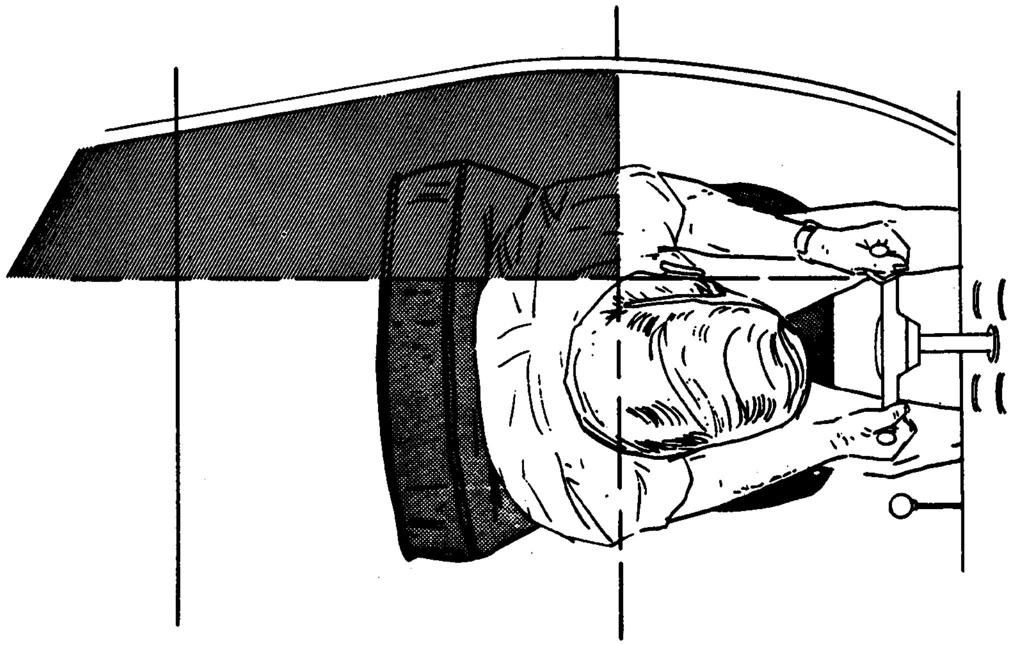


FIGURE 9.5.—Acceptable mounting area—single diagonal type harness.

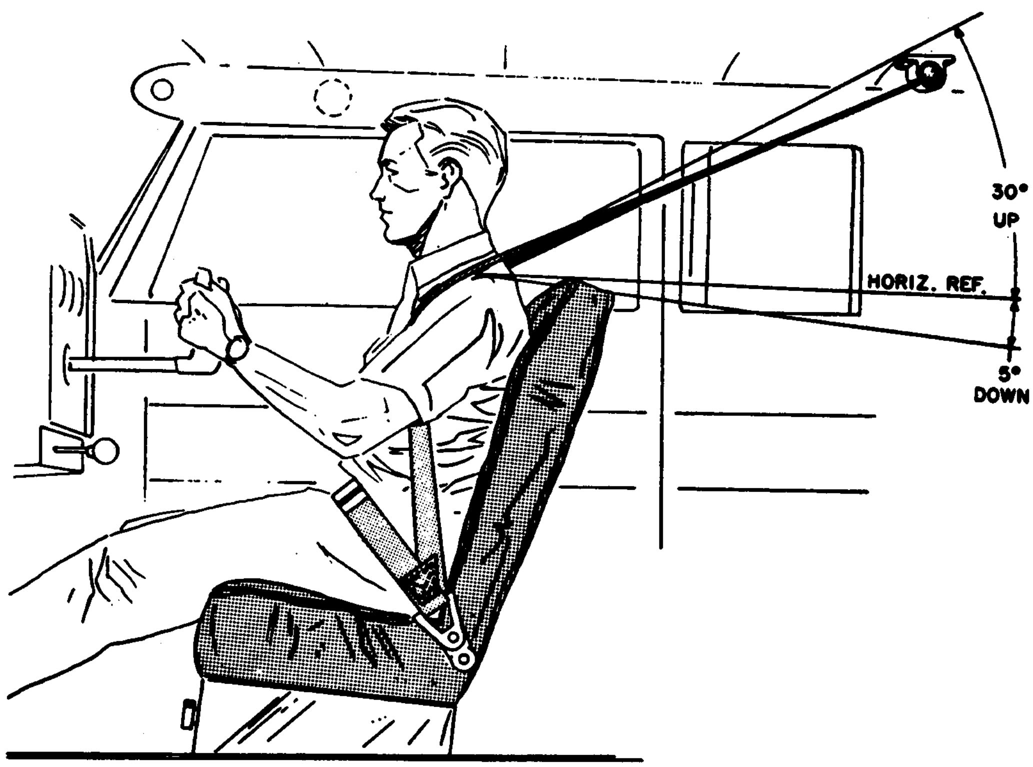


FIGURE 9.6.—Ceiling mounted inertia reel—double over-the-shoulder type harness.

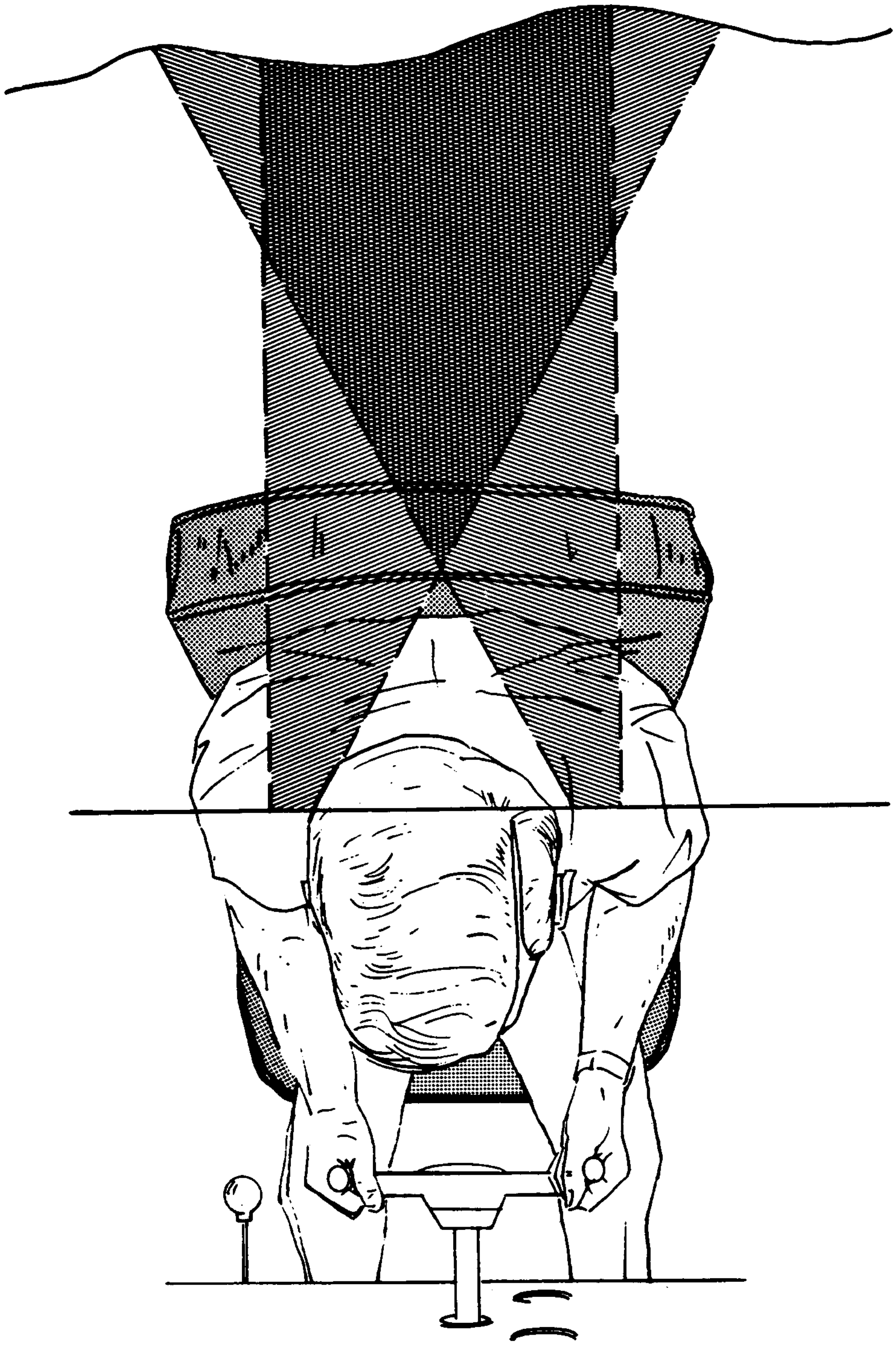


FIGURE 9.7.—Acceptable mounting areas—double over-the-shoulder type harness.

159.-160. [RESERVED]

Section 3. ATTACHMENT METHODS

161. STRUCTURAL ATTACHMENTS. For best results, the restraint system should be anchored to the primary aircraft structure. Design the structural attachment to spread the suddenly applied impact loads over as large an area of the structure as possible. The shoulder harness may be attached to selected secondary members which will deform slowly or collapse at a limited rate. This will assist in dissipating the high impact "g" loads to a level tolerable to the human body. However, the possibility of secondary members collapsing and making it difficult for an occupant to extract himself from the harness should not be overlooked.

162. FLOOR AND SEAT ATTACHMENTS. The double over-the-shoulder type harness shown in figure 9.8 may be used with either floor or seat mounting points, and typical installation methods are illustrated in figures 9.9 and 9.10. Two prerequisites necessary to ensure an effective restraint system are:

a. The seat structure and its anchorages should be capable of withstanding the additional "g" loads imposed by the restrained occupant during an abrupt deceleration. This capability may be determined by static testing in accordance with FAR 23.785, 25.785, 27.785, or 29.785, as appropriate; or, by securing a statement attesting this adequacy from the airframe manufacturer's engineering department.

b. The level of the seat back should at least be equal to the shoulder height of the seated occupant. This will reduce the inherent downward impact loads which would otherwise impart compressive forces on the occupant's torso.

FIGURE 9.8.—Floor mounted inertia reel—double over-the-shoulder type harness.

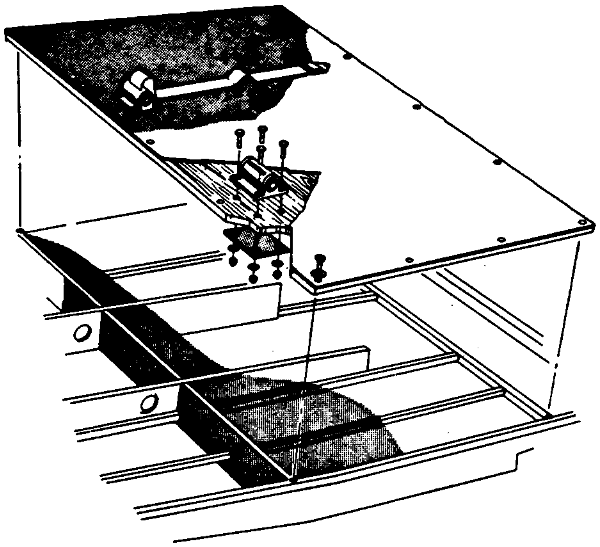


FIGURE 9.9.—Typical floor mounted inertia reel installation.

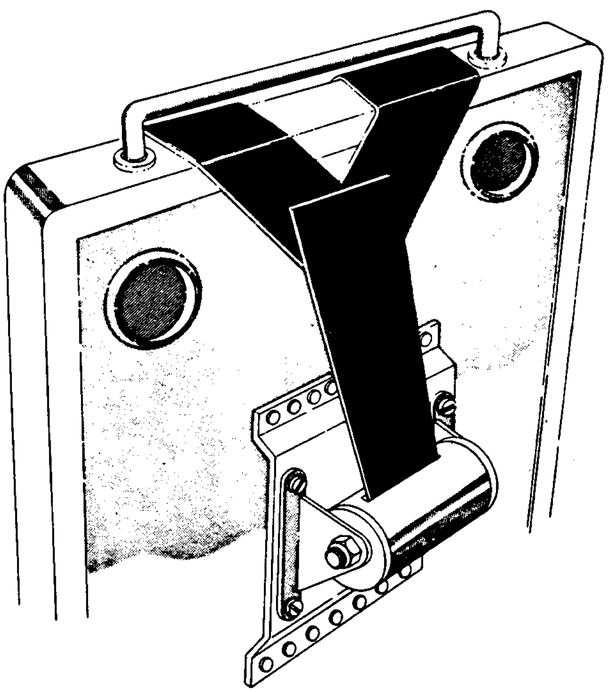


FIGURE 9.10.—Typical seat mounted inertia reel installation.

Seats which utilize a fold-over type of seat back must have some type of locking mechanism so that the seat can support the loads without allowing the occupant to move forward. The lock should be of a type which has a quick release to allow rear seat occupants to rapidly evacuate the aircraft. This type of installation should only be considered if other means of attachment are not available since making a folding seat rigid greatly reduces the protection afforded a passenger to the rear. When a folding seat is provided with a lock, the passenger to the rear should also be provided a shoulder restraint system, or, the back of the forward seat should be provided with sufficient absorptive material to adequately compensate for the added rigidity. Also, the change in load distribution due to the loads being applied to the seat back may require reinforcing the seat and/or belt anchorages to meet airworthiness requirements.

163. AIRFRAME ATTACHMENTS. The method used for the attachment of shoulder harness anchorages is dependent upon the construction features of the aircraft involved.

a. Monocoque/Semimonocoque Type Constructions. Illustrations of typical aircraft members and installation methods are shown in figures 9.11 through 9.15.

b. Tube Type Construction. Various typical methods of attaching shoulder harness anchorages are shown in figure 9.16. When aircraft cable is used as a component in a shoulder harness anchorages, swage the cable terminals in accordance with the procedures contained in chapter 4 of AC 43.13–1A, "Acceptable Methods, Techniques, and Practices—Aircraft Inspection and Repairs."

164. STRUCTURAL REPAIR KITS. In many instances, structural repair kits are available from the aircraft manufacturer. While these kits are primarily intended for use in repairing defective or damaged structure, they may also be used as a reinforcement for shoulder harness attach fittings.

165. FLEXIBLE ATTACHMENTS. Various aircraft are designed so that fuselage members and/or skin will flex or "work." This type of structure should not be heavily reinforced for the purpose of attaching shoulder harnesses as this would defeat the design purpose. In cases such as these, use a localized reinforcement, such as shown in figure 9.15, at the attachment point. This will allow the fuselage to flex while still maintaining a collapsible structure to absorb the loads encountered in a crash.

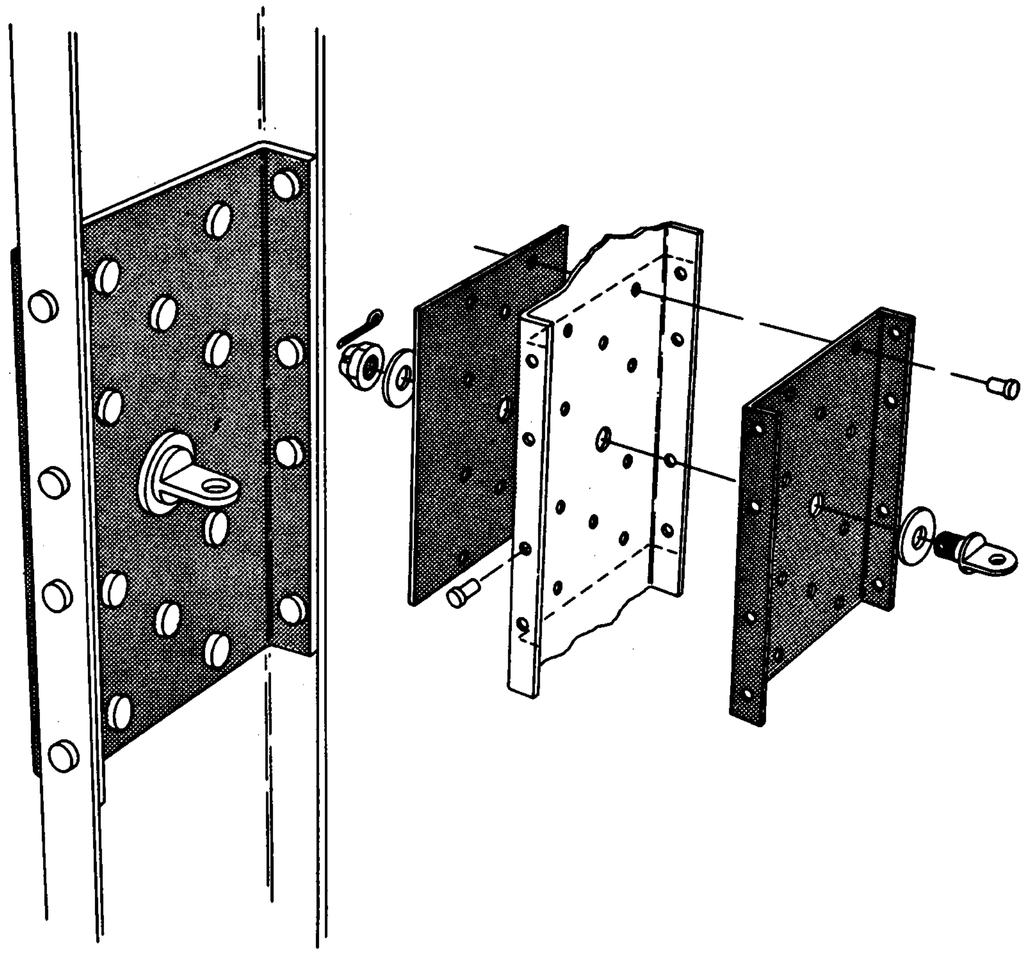


FIGURE 9.11.—Typical bulkhead reinforcement installation.

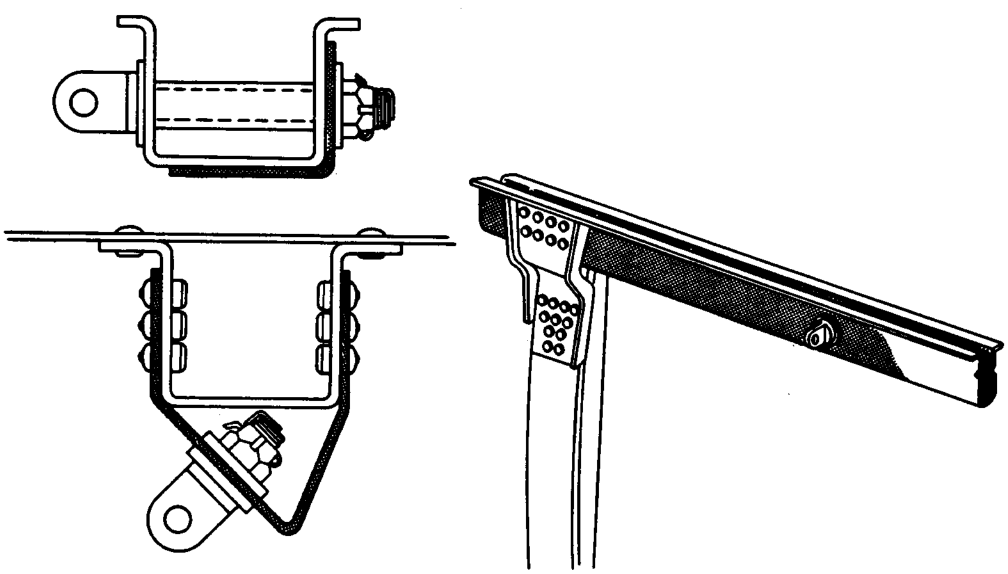


FIGURE 9.12.—Typical wing carry-through member installation.

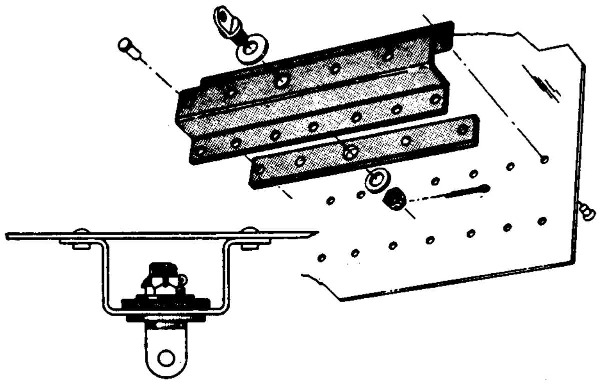


FIGURE 9.13.—Typical hat section reinforcement installation.

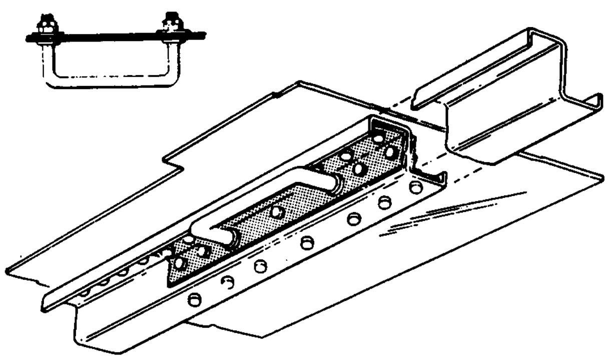


FIGURE 9.14.—Typical stringer section reinforcement installation.

166. SIMPLIFIED INSTALLATION CRITERIA. To encourage the addition of shoulder restraints to existing aircraft with a minimum of testing and engineering necessary, yet provide a satisfactory restraint, the following general conditions will be acceptable.

a. ***Utilize the original seat belt attachments*** and either the original or a new belt provided with shoulder harness fittings.

b. ***Use webbing approved*** for standard seat belts (TSO-C22f).

c. ***Use hardware approved*** for use on seat belts per TSO-C22f.

d. ***Secure the lower end of the shoulder strap*** to one side of the original seat belt or belt anchorage.

e. ***Use a mount*** for the shoulder restraint independent of the seat such as the aft or ceiling mounts per paragraph 128.

f. ***Test the added mount*** by applying a test load of at least 500 pounds forward at the shoulder point.

167. ENGINEERING APPROVAL. Installations which involve cutting or drilling of critical fuselage members or skin of pressurized aircraft will usually require engineering evaluation. For this reason it may be desirable to contact the airframe manufacturer to obtain his recommendations.

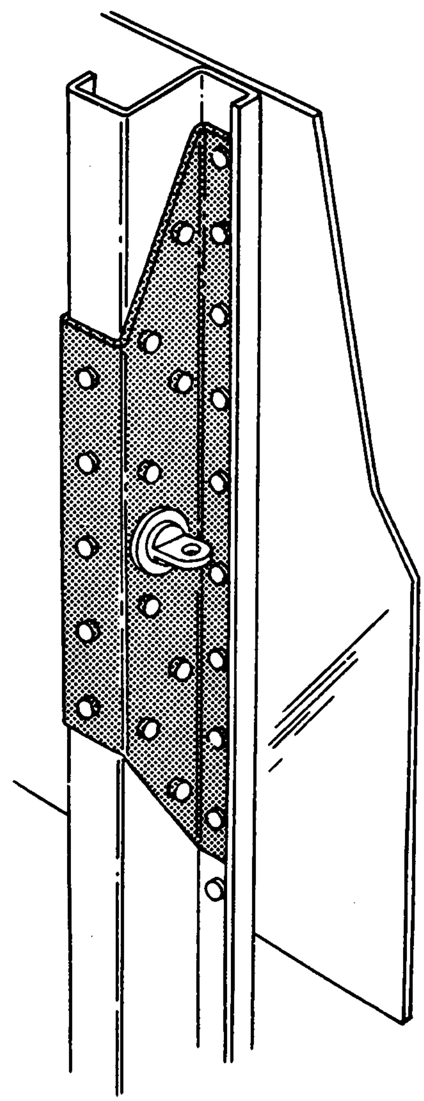


FIGURE 9.15.—Typical stringer section reinforcement installation.

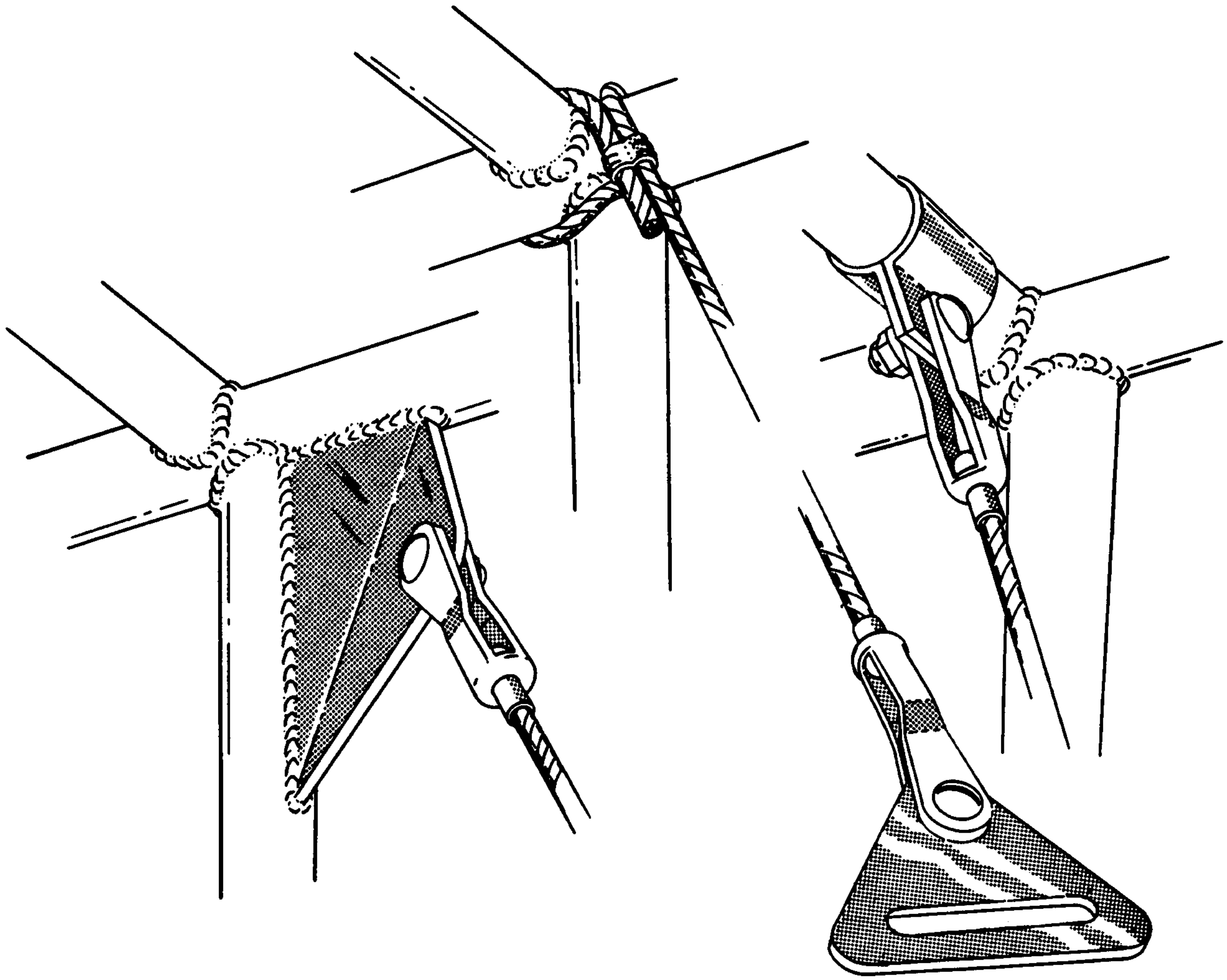


FIGURE 9.16.—Typical attachment to tubular members (adequate chafing protection for tube should be provided. Detail omitted for clarity.)

168.-175. [RESERVED]

Chapter 10. BATTERY INSTALLATIONS

Section 1. GENERAL

176. GENERAL. This section contains structural and design considerations for the fabrication of aircraft battery installations.

177. LOCATION REQUIREMENTS. The battery location and/or its installation should provide:

a. Accessibility for Battery Maintenance and Removal. The electrolyte level of the battery needs frequent checking; therefore, install the battery so that it is readily accessible for this service without the removal of cowling, seats, fairings, etc. Inaccessibility is often the source of neglect of this important piece of equipment. Certain types of batteries cannot be conveniently serviced while installed. Therefore, install and/or locate the battery so that it can be readily removed and reinstalled.

b. Protection from Engine Heat. The installation should protect the battery from extreme engine heat, which would be detrimental to the battery's service life and reliability. Such protection should provide for the temperatures encountered after engine shutdown as well as during engine operation. When locating the battery within the engine compartment, choose a location that will not interfere with the flow of engine-cooling air.

c. Protection from Mechanical Damage. Vibration and other shock loads are a major cause of short battery life. Whenever possible, install the battery in a manner or location that will minimize damage from airframe vibration and prevent accidental damage by passengers or cargo.

d. Passenger Protection. Enclose the battery in a box or other suitable structure to protect

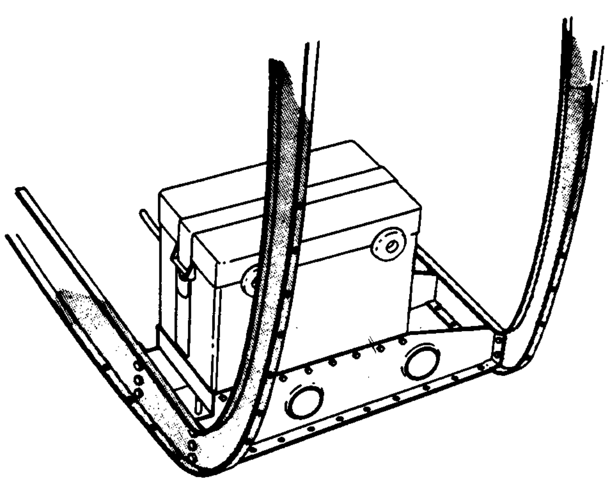


FIGURE 10.1.—Typical battery box installation in aft fuselage area.

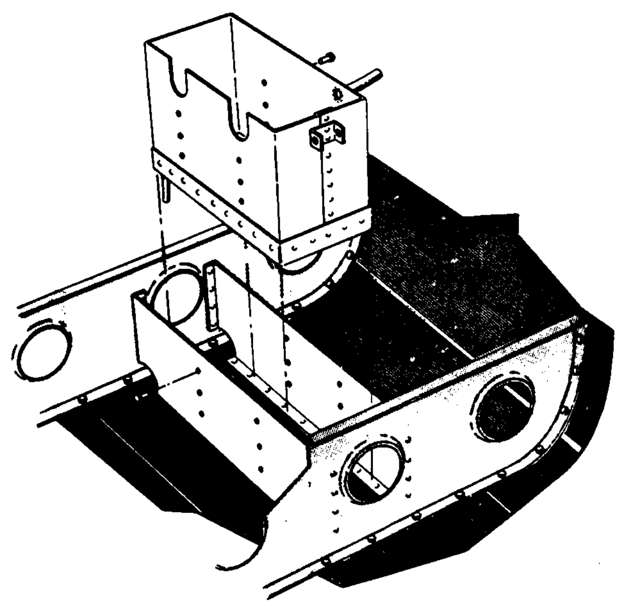


FIGURE 10.2.—Typical battery box installation in aft fuselage area, below cabin floorboards, or may also be adapted for within wing locations (shaded portions indicate original structure).

passengers from any fumes or electrolyte that may be spilled as a result of battery overheating, minor crash, inverted flight, and/or rapid decompression if the battery is located within the aircraft's pressure vessel.

e. ***Airframe Protection***. Protect the airframe structure and fluid lines by applying asphaltic- or rubber-base paint to the areas adjacent to and below the battery or battery box. Apply paralketone, heavy grease, or other comparable protective coating to control cables in the vicinity of the battery or battery box. Damage to adjacent fabric covering and electrical equipment can be minimized by providing a battery sump jar containing a neutralizing agent, properly locating battery drains and vent discharge lines, and adequately venting the battery compartment.

178. DUPLICATION OF THE MANUFACTURER'S INSTALLATION. The availability of readymade parts and attachment fittings may make it desirable to consider the location and type of installation selected and designed by the airframe manufacturer. Appreciable savings in time and work may be realized if previously approved data and/or parts are used.

179. OTHER INSTALLATIONS. If the battery installation has not been previously approved, or if the battery is to be installed or relocated in a manner or location other than provided in previously approved data, perform static tests on the completed installation as outlined in chapter 1 of this handbook. Because of the concentrated mass of the battery, the support structure should also be rigid enough to prevent undue vibration which would lead to early structural failure. Typical illustrations of battery support structure are shown in figures 10.1 thru 10.4.

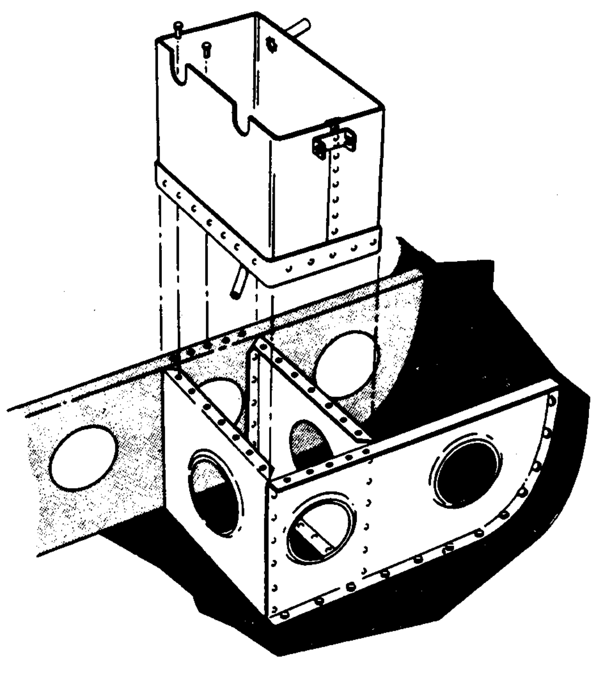


FIGURE 10.3.—Typical battery box installation in aft fuselage area (shaded portions indicate original structure).

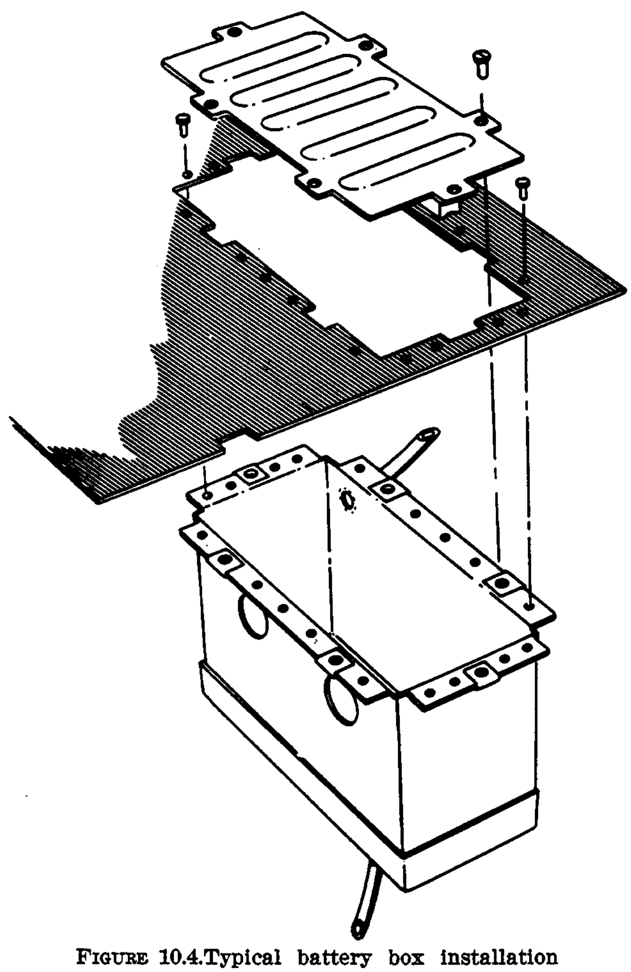


FIGURE 10.4.Typical battery box installation suspended from cabin floorboard section.

180.–185. [RESERVED]

Section 2. INSTALLATION

186. SECURING THE BATTERY. Install the battery box or holddowns in such a manner as to hold the battery securely in place without subjecting it to excessive localized pressure which may distort or crack the battery case. Use rubber or wooden blocks protected with parafin or asphaltic paint as spacers within the battery box, as necessary, to prevent shifting of the battery and possible shorting of the battery terminals or cables. Also, provide adequate clearance between the battery and any bolts and/or rivets which may protrude into the battery box or compartment.

187. VENTING. Provide suitable venting to the battery compartment to prevent the accumulation of the hydrogen gas evolved during operation. For most aircraft batteries, an airflow of 5 cu. ft. per minute is sufficient to purge the battery compartment of explosive concentrations of hydrogen.

a. Manifold Type. In this type of venting, one or more batteries are connected, via battery or battery box vent nipples, to a hose or tube manifold system as shown in figure 10.5. Fasten such hoses securely to prevent shifting and maintain adequate bend radii to prevent kinking.

(1) ***The upstream side of the system*** is connected to a positive pressure point on the aircraft, and the downstream side is usually discharged overboard to a negative pressure area. It is advisable to install a battery sump jar in the downstream side to neutralize any corrosive vapors that may be discharged.

(2) ***When selecting these pressure points,*** select points that will always provide the proper direction of airflow through the manifold system during all normal operating attitudes. Reversals of flow within the vent system should not be permitted when a battery sump jar is installed, as the neutralizing agent in the jar may contaminate the electrolyte within the battery.

b. Free Airflow Type. Battery cases or boxes that contain louvers may be installed without an individual vent system, provided:

(1) The compartment in which the battery is installed has sufficient airflow to prevent the accumulation of explosive mixtures of hydrogen;

(2) Noxious fumes are directed away from occupants; and

(3) Suitable precautions are taken to prevent corrosive battery fluids or vapors from damaging surrounding structure, covering, equipment, control cables, wiring, etc.

188. DRAINS. Position battery compartment drains so that they do not allow spillage to come in contact with the aircraft during either ground or flight attitudes. Route the drains so that they have a positive slope without traps. Drains should be at least ½″ in diameter to prevent clogging.

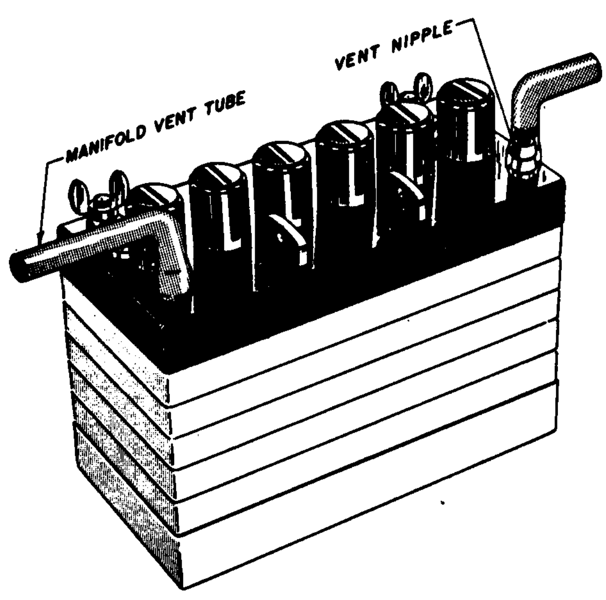


FIGURE 10.5.—Battery with integral vent nipples.

189. ELECTRICAL INSTALLATION.

a. *Cables/Connectors*. Use cables and/or connectors that are adequately rated for the current demand and are properly installed (See AC 43.13–1A, "Acceptable Methods, Techniques, and Practices—Aircraft Inspection and Repair," chapter 11). It may be necessary to contact the battery manufacturer to determine current value of the battery at the 5-minute discharge rate. Cable size can also be selected by using the same gage as used on a previously approved production aircraft with the same battery.

(1) The cables should be of sufficient length to prevent undue strain on the battery connector or terminals.

(2) Clamp and protect cables, including the bus, in a very secure manner. Since these units are not fused, any fault could cause loss of the entire electrical system in addition to a possible fire hazard.

(3) Route cables so that cable or terminals cannot short to the battery case or hold-down frame.

(4) Route cables outside the battery box whenever practicable to prevent corrosion by acid fumes. When internal routing is unavoidable, protect the cable inside the box with acid-proof tubing. Assure that cables will not be inadvertently reversed on the battery terminals either by proper cable lengths and clamps or, if this is not practicable, use conspicuous color coding.

b. *Battery Cutoff*. Install a battery cutoff relay to provide a means of isolating the battery from the aircraft's electrical system. An acceptable battery cutoff circuit is shown in figure 10.6. Mount the relay so that the cable connecting the relay to the battery is as short as feasible, in any case not to exceed two feet, to reduce the possibility of a fire occurring because of a short within this section of cable.

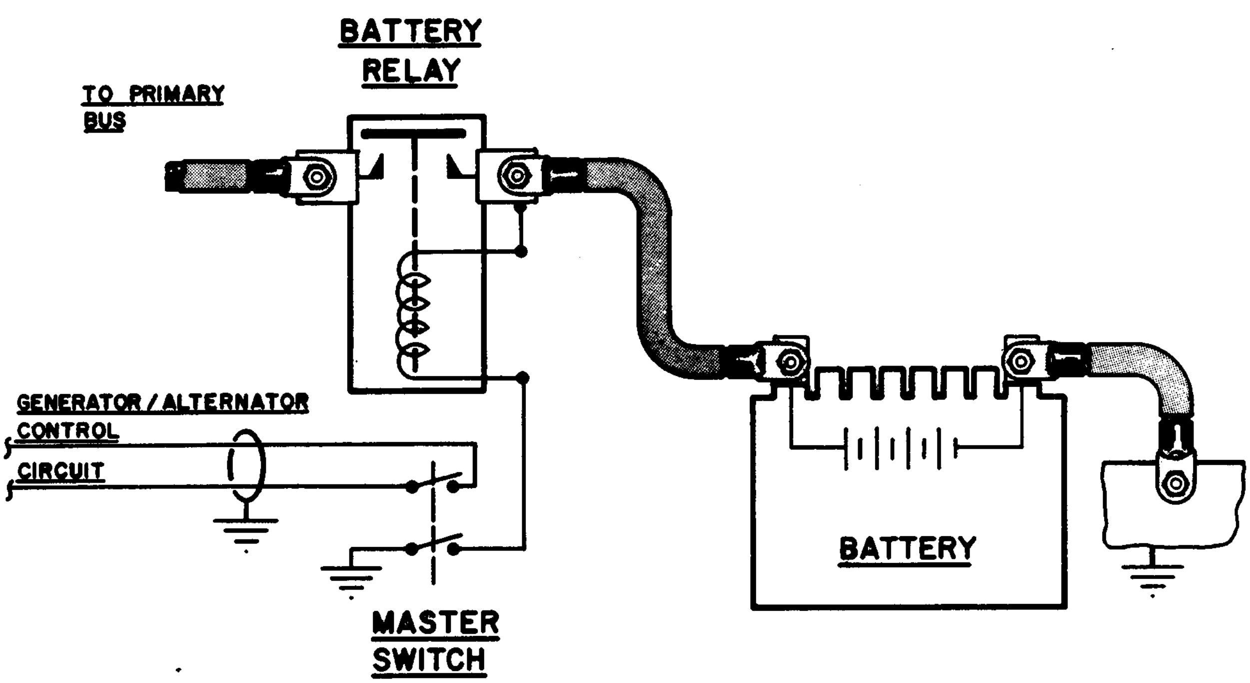


FIGURE 10.6.—Typical battery cutoff and generator alternator control circuit.

190.–195. [RESERVED]

Section 3. REPLACEMENT OF LEAD-ACID BATTERIES WITH NICKEL-CADMIUM BATTERIES

196. GENERAL. Nickel-cadmium batteries fulfill a need for a power source that will provide large amounts of current, fast recharge capability, and a high degree of reliability. The exchange of lead-acid for nickel-cadmium batteries requires careful evaluation of certain areas.

197. ELECTRICAL ANALYSIS. The ampere hour capacity of a nickel-cadmium battery is selected to accommodate the aircraft load requirements. When making this selection, the following items should be considered.

a. ***The low internal resistance*** permits it to recharge very quickly. This high recharge rate can exceed the generator rated capacity and deprive essential circuits of necessary operating current. Total system load (battery recharging plus system loads) must not exceed the pre-established electrical capacity.

b. ***Compare the discharge characteristics curves*** of the batteries to make sure a reduced capacity nickel-cadmium battery is adequate regarding the following:

(1) Ability to provide engine starting or cranking requirements. Turbine engines require an initial surge of approximately 1200 amperes which tapers off within 10 seconds to approximately 800 amperes cranking current. Reciprocating engines require approximately 100 amperes cranking current.

(2) Ability to provide sufficient capacity for low temperature starting. Nickel-cadmium batteries deliver their rated capacity when the ambient temperature range is 70° to 90° F. Increased battery capacity will offset the effects of low-temperature starting.

198. MAINTENANCE CONSIDERATIONS. To provide for ease of inspection and because nickel-cadmium batteries are generally not serviced in the aircraft, it is important that the battery be located where it can easily be inspected, removed, and installed. Some battery cases are designed with viewports on each side of the case for visual monitoring of the cell electrolyte level. If this type of case is to be utilized, consideration should be given to the location of the battery compartment to accommodate this feature.

199. STRUCTURAL REQUIREMENTS. Most lead-acid battery compartments provide adequate structure attachment for the installation of nickel-cadmium batteries. However, cantiliver supported battery boxes/compartments may not be suitable for nickel-cadmium battery installations unless modified to compensate for an increased overhang moment. This may be caused by a change in battery shape and c.g. location even though the replacement battery weighs less than the original lead-acid battery. (See fig. 10.7.) When ever the total installation weight and/or the overhang moment exceed those of the original installation, perform a static test as outlined in chapter 1 of the handbook. If the battery compartment is to be relocated, follow the procedures outlined in Sections 1 and 2 of this chapter.

200. ISOLATION OF BATTERY CASE. Because of the material from which nickel-cadmium battery cases are generally made (stainless or epoxy coated steel), it is desirable to electrically isolate the case from aircraft structure. This will eliminate the potential discharge current produced when spillage or spewage of the electrolyte provides a current path between the cell terminal or connector and exposed metal of the battery case. This isolation is also desirable in that it could prevent a fault within the battery or faulting the generator output to the stucture.

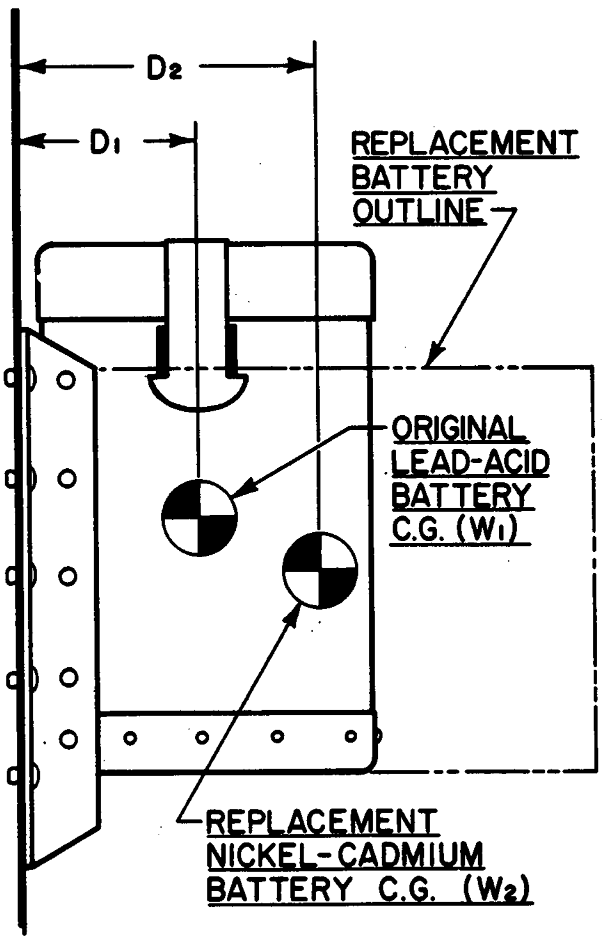


FIGURE 10.7.—Change in cantilever support battery overhang moment.

Example:

Original Overhang Moment with Lead-Acid Battery

W_1 = 25 lb.,

D_1 = 4 inches

4 inches X 25 lb., = 100 in.−lb.

New Overhang Moment with Replacement Nickel-Cadmium Battery

W_2 = 19.5 lb.,

D_2 = 6 inches

6 inches X 19.5 lb. = 117 in.−lb.

201. VENTILATION. During the charging process, nickel-cadmium batteries produce hydrogen and oxygen gases. This occurs near the end of the charging cycle when the battery reaches what is called the gassing potential. To avoid a build-up of these gases, and possible accidental ignition, ventilation should be provided to evacuate this gas from the aircraft. There are two types of nickel-cadmium battery cases, one with vent nozzles and the type with viewports.

a. ***The vent nozzle type*** utilizes vent hoses to evacuate the gas overboard by use of forced air or by venturi effect.

b. ***Battery cases with viewports*** or louvers must have an air flow sufficient to keep the mixture of air and hydrogen below 4 percent. The gases from this type of case are evacuated into the battery compartment. Regardless of the ventilation system used, the air flow should be a minimum of 5 cubic feet per minute.

202. PREINSTALLATION REQUIREMENTS. Inspect the replacement battery for possible damage incurred during shipment or storage. Give particular attention to signs of spilled liquid within the shipping container, as it may indicate a damaged cell. Follow procedures outlined in Section 2 for battery venting and electrical connections.

a. ***Preinstallation battery servicing.*** Check at least the following in accordance with the battery manufacturer's instruction:

(1) Remove the shipping plugs (if used) and clean and install the filler cap vent plugs.

(2) Check the tightness of terminal hardware including each cell connector strap to the proper torque values.

(3) Check the polarity of each cell to be sure they are connected in the proper series or sequence.

(4) Charge and check battery voltage and electrolyte level.

b. ***Compartments or battery boxes*** which have previously housed lead-acid batteries must be washed out, neutralized with ammonia or a baking soda solution, allowed to dry thoroughly, and painted with alkaline-resistant paint. Remove all traces of sulfuric acid and its corrosion products from the battery vent system to prevent contamination of the potassium hydroxide electrolyte and/or possible damage to the cell case material. Replace those parts of the vent system which cannot be thoroughly cleansed (hoses, etc.). When sump jars are incorporated into the vent system, replace the old pad with a new one that has been saturated in a three-percent solution (by weight) of boric acid and water.

203. SECURING THE BATTERY. Follow the procedures outlined in Section 2 of this chapter. Make certain that the holddown bolts are not drawn up so tightly that the battery case/cover becomes distorted. Should the cover become distorted, there is a possibility that the cell terminal hardware may eventually puncture the neoprene cover liner used in many batteries, and short circuit.

Caution: In installations where care has been taken to isolate the battery cases, inadvertent grounding may occur through improper or careless use of safety wire. Use no wood in nickel-cadmium battery boxes as it becomes conductive with time causing a current flow from the battery case to ground. Use only fiberglass or other acceptable material as liners and spacers in the battery box.

204. VOLTAGE AND CURRENT REGULATION. It is essential that the charging voltage and current be checked and, if necessary, the voltage regulator reset to meet the requirements of the nickel-cadmium battery being installed. IMPORTANT——improper charging current or voltage can destroy a battery in a short period of time.

205. WEIGHT AND BALANCE. After installation of the nickel-cadmium battery the weight and balance of the aircraft should be recomputed if:

a. ***The weight*** of the nickel-cadmium battery is different from that of the original lead-acid battery.

b. ***The location*** of the nickel-cadmium battery is different from that of the original lead-acid battery.

Weight and balance procedures for aircraft are contained in chapter 13 of AC 43.13–1A.

206. RESTORATION OF LEAD-ACID BATTERIES. When lead-acid batteries are restored in lieu of nickel-cadmium batteries the procedures contained in sections 1, 2, and 3 of this chapter should be used. Structural requirements are referenced in paragraph 199 and figure 10.7.

Airframe protection is specified in paragraph 177. Follow the procedures outlined in section 2 of this chapter for battery security, battery venting, and battery drains. Assure that all electrical requirements have been accomplished. Place emphasis on aircraft weight and balance. Refer to chapter 13 of AC 43.13–1A.

207.–210. [RESERVED]

Chapter 11. ADDING OR RELOCATING INSTRUMENTS

211. GENERAL. This chapter contains structural and design information to be considered when aircraft alterations involving the addition and relocation of instruments are being made.

212. PREPARATION. First determine what regulation, (CAR 3, 4b, FAR 23, 25, etc.) is the basis for the aircraft type certificate. That regulation establishes the structural and performance requirements to be considered when instruments are to be added or relocated.

a. *Structure*. Chapter 1 of this handbook provides information by which structural integrity may be determined. Chapter 2, paragraph 23a through f provides information pertinent to instrument panel installation.

b. *Location*. Consult the applicable regulation for the specific requirements for instrument location and arrangement.

(1) In the absence of specific requirements, installation of IFR flight instruments in a "T" arrangement is recommended. Locate the aircraft attitude indicator at top center, airspeed indicator to the left, altimeter to the right and directional indicator directly below, thus forming the letter "T." When a radio altimeter is used, the indicator may be placed on the immediate right of the attitude indicator with the pressure altimeter to the right of the radio altimeter indicator.

213. INSTALLATION. Mount all instruments so they are visible to the crewmember primarily responsible for their use. Mount self-contained gyroscopic instruments so that the sensitive axis is parallel to the aircraft longitudinal axis.

a. *Structure*. When making structural changes such as adding holes in the instrument panel to mount instruments, refer to chapter 2, paragraph 23a through f of this handbook. Refer to the aircraft manufacturer's instructions and Advisory Circular 43.13–1A, "Acceptable Methods, Techniques, and Practices—Aircraft Inspection and Repair," chapter 2, section 3, for methods and techniques of retaining structural integrity.

b. *Plumbing*. Refer to the manufacturer's instructions for fabrication, routing and installation of instrument system lines. Advisory Circular 43.13–1A provides information regarding the installation and fabrication of aircraft plumbing.

c. *Vacuum Source*. Minimum requirements for installation and performance of instrument vacuum systems are covered in the applicable FAR Airworthiness Standards under "Instruments: Installation."

(1) In the absence of specific requirements for vacuum pump installation, refer to FAR Part 25, section 25.1433 for guidance. It is desirable to install a "T" fitting between the pump and relief valve to facilitate ground checking and adjustment of the system.

(2) When a venturi tube power source is used, it should not be taken for granted that a venturi will produce sufficient vacuum to properly operate one or more instruments. Many of the venturi tubes available for aircraft have a flow rate of approximately 2.3 cubic feet per minute at 3.75 inches of mercury (in. Hg) vacuum. Therefore, it is essential that the vacuum load requirements be carefully evaluated.

(3) Vacuum loads may be calculated as follows:

(a) Gyroscopic instruments require optimum value of airflow to produce their rated rotor speed. For instance, a bank and pitch indicator requires approximately 2.30 cubic feet per minute for its operation and a resistance or pressure drop of 4.00 in. Hg. Therefore, operating an instrument requiring 4.00 in. Hg from one venturi would be marginal. Similarly, the directional gyro indicator consumes approximately 1.30 cubic feet per minute and a pressure drop of 4.00 in. Hg. The turn and bank indicator has a flow requirement of 0.50 cubic feet per minute and reaches this flow at a pressure drop of 2.00 in. Hg. The above instruments are listed in Tables 11.1 and 11.3. Optimum values are shown in Table 11.3. It should be noted that the negative pressure air source must not only deliver the optimum value of vacuum to the instruments, but must

Table 11.1.—Instrument air consumption.

Instrument	*Air consumption at sea level*	
	Differential drop in. Hg suction (Optimum)	*Cubic feet/per minute*
AUTOMATIC PILOT SYSTEM (Types A-2, A-3, & A-3A)		
Directional gyro control unit across mount assembly	5.00	2.15*
Bank & climb gyro control unit across mount assembly	5.00	3.85*
Total	—	6.00*
AUTOMATIC PILOT SYSTEM (Type A-4)		
Directional gyro control unit	5.00	3.50*
Bank & climb gyro control unit	5.00	5.00*
Total	—	8.50*
Bank & pitch indicator	4.00	2.30
Directional gyro indicator	4.00	1.30
Turn & bank indicator	2.00	.50

(*) NOTE.—Includes air required for operation of pneumatic relays.

also have sufficient volume capacity to accommodate the total flow requirements of the various instruments which it serves.

(b) To calculate the flow requirements of a simple vacuum system, assume four right-angle elbows and 20 feet of line (½ O.D. x .042) tubing.

1 Assume the flow requirements for:

Turn & bank indicator	.50 CFM
Directional gyro indicator	1.30 CFM
Bank & pitch indicator	2.30 CFM
Total flow required	4.10 CFM

2 The pressure drop for one 90° ½-inch O.D. x .042 elbow is equivalent to 0.62 feet of straight tubing, figure 11.1. Therefore, the pressure drop of four 90° elbows is equivalent to 2.48 feet of tubing.

Table 11.2.—Equivalent straight tube line drops for 90° elbows.

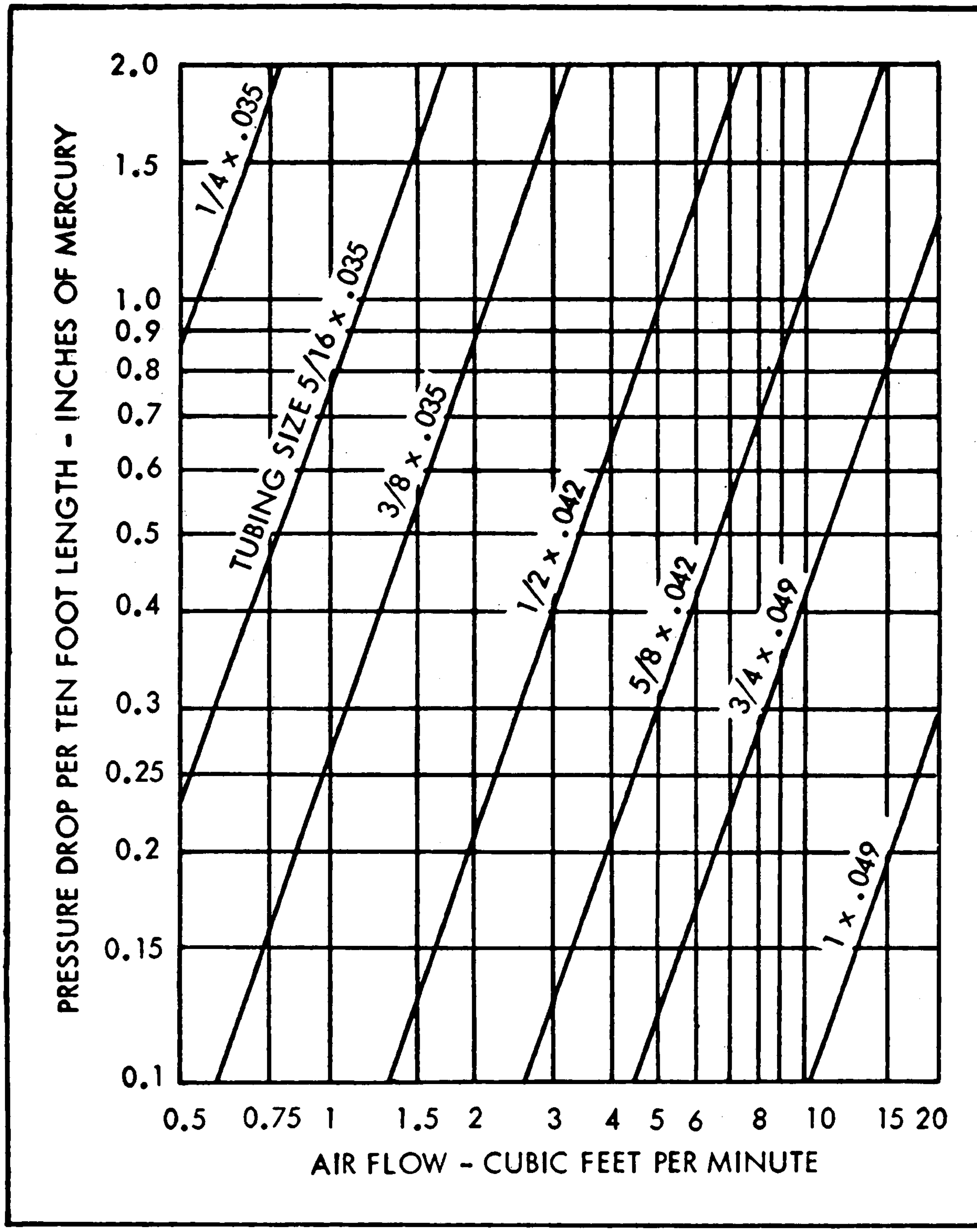
Tubing size			*Pressure drop in a 90° elbow in terms of length of straight tube equivalent to a 90° elbow*
O.D inch		*Wall thickness inch*	*Feet*
¼	×	.035	0.28
⅜	×	.035	0.46
½	×	.042	0.62
⅝	×	.042	0.81
¾	×	.049	0.98
1	×	.049	1.35

3 Determine the pressure drop through 22.48 feet (20 feet + 2.48 equivalent feet) of ½ O.D. × .042 tubing at 4.10 CFM flow. From figure 11.1, pressure drop per each 10-foot length = 0.68 in. Hg. Divide 22.48 feet of tubing by 10 to obtain the number of 10-foot sections, i.e., 22.48 ÷ 10 = 2.248. Multiply the number of sections by 0.68 in. Hg to obtain the pressure drop through the system. (0.68 × 2.248 = 1.53 in. Hg)

4 The pump must therefore be capable of producing a minimum pressure differential of

Table 11.3.—Differential pressure across instrument inlet and outlet.

Instrument	*Suction in inches of mercury*		
	Minimum	*Optimum*	*Maximum*
AUTOMATIC PILOT SYSTEM (Types A-2, A-3, & A-3A)			
Directional gyro control unit across mount assembly	4.75	5.00	5.25
Bank & climb gyro control unit across mount assembly	4.75	5.00	5.25
Gauge reading (differential gauge in B & C control unit)	3.75	4.00	4.25
AUTOMATIC PILOT SYSTEM (Type A-4)			
Directional gyro control unit	3.75	5.00	5.00
Bank & climb gyro control unit	3.75	5.00	5.00
Bank & pitch indicator	3.75	4.00	5.00
Directional gyro indicator	3.75	4.00	5.00
Turn & bank indicator	1.80	2.00	2.20



PRESSURE DROP DATA FOR SMOOTH TUBING

FIGURE 11.1

5.53 in. Hg, i.e., 4.00 in. Hg for maximum instrument usage + 1.53 in. Hg (determined) at a flow of 4.10 cubic feet per minute.

d. ***Filter***. Filters are used to prevent dust, lint and other foreign matter from entering the instrument and vacuum system. Filters may be located at the instrument intake port or at the manifold intake port when instruments are interconnected. Determine that the capacity of the filter is as great or greater than the capacity of the vacuum system. Assure that there is no pressure drop across the filter media.

e. ***Electrical Supply for Instruments***. Guidelines for the installation of instrument electrical wiring and power source are provided in Advisory Circular 43.13–1A, chapter 11, sections 2 and 3, and Chapter 16, section 3.

NOTE: Strict conformance to the shielding specifications supplied by compass manufacturers is recommended in all installations to eliminate any possibility of spurious signals.

f. ***Instrument Lighting***. Instrument lighting must be installed in accordance with the regulations that are applicable to the aircraft type certification requirements. If in some instances the reflection of the lights is unsatisfactory, provide a shield or a means for controlling the intensity of illumination.

g. ***Magnetic Headings***. Calibrate magnetic instruments with the powerplants operating. After this initial calibration, switch all nav/com and electrical equipment, such as windshield wipers and defrosters, "on" to determine if any electrical system interference affects the instrument calibration. If the calibration is affected, prepare an instrument placard identifying the compass headings with the equipment "on" and also with the equipment "off." Placard in accordance with par. 214f of this chapter.

214. TESTING, MARKING, AND PLACARDING.

a. ***Testing the Venturi Tube-Powered Systems***. At normal inflight cruise speed, check the venturi tube-powered system to assure that the required vacuum pressure is being supplied.

b. ***Testing the Vacuum Air Pump Powered System***. When the system is powered by vacuum air pumps, check the system while the pumps are operating at their rated r.p.m. and measure the vacum available to the instruments.

c. ***Testing of Altimeters and Static Systems***. When checking the operation of an altimeter static system to determine that the system is free of any contaminating materials, be sure to disconnect the plumbing from all air operated instruments before purging the lines with dry air or nitrogen since the pressure necessary for purging may damage any connected instrument. Static system test procedures are provided in FAR 43, Appendix E.

d. ***Testing electrical supply (instruments)***. Check the voltage at the instrument terminals and determine that it is equal to the manufacturer's recommended values.

e. ***Fuel, Oil, and Hydraulic (Instrument Supply)***. Measure the fluid pressure at the instrument end of the line to determine whether it is equivalent to that at the pressure source.

f. ***Instrument Markings and Placards***. When additional instruments are installed they must be appropriately marked. Refer to the applicable CAR/FAR under "Markings and Placards" for specific instrument marking and placard requirements.

215.–240. [RESERVED]

Chapter 12. LITTER, BERTH, AND CARGO TIEDOWN DEVICE INSTALLATIONS

241. GENERAL. This chapter provides data for making acceptable litter, berth, and cargo tiedown device installations in airplanes and rotorcraft. Prior to proceeding with the alteration, determine the airworthiness standards applicable to the contemplated alteration. Refer to the proper volume of the FAA publication "Type Certificate Data Sheets and Specification" for the certification basis of the aircraft involved. When airworthiness standards pertinent to the airplane involved are not available, current airworthiness standards may be used. For example, FAR 23, 25, 27, or 29, as applicable, may be used in place of CAR 4a, 4b, 6, or 7 or Bulletin 7a.

242: INSTALLATION CONSIDERATIONS.

a. Assure that the altered aircraft can be operated within the weight and center of gravity ranges. Refer to chapter 1, paragraph 9 of this handbook.

b. Determine that there will be free access to all equipment and controls essential to the proper operation of the aircraft, required emergency exits, and emergency equipment.

c. Use only materials that are at least flame-resistant for covering of floors, litters, or berths. Refer to the applicable airworthiness standards for the aircraft involved to determine the required flame-resistant qualities. For aircraft in air taxi or other commercial operations, refer to the applicable operating rule for special requirements regarding fire protection, cargo bins, location of cargo with respect to passengers, cargo compartment, or aisle width.

243. FABRICATION AND INSTALLATION.

a. Litters and berths may be fabricated from tubing, sheet metal, extrusions, canvas, webbing, or other suitable material, using acceptable methods, techniques, and practices. (Ref. Advisory Circular 43.13-1A "Acceptable Methods, Techniques, and Practices—Aircraft Inspection and Repair") Commercially available litters or stretchers may be utilized provided they meet installation and load criteria.

Provide a padded end board, canvas diaphragm, or other means at the forward end of each litter or berth that will withstand the total forward static test load. Safety belts used for litters and berths installed parallel to the aircraft's longitudinal axis are not required to withstand forward loads as these loads are to be taken up by the padded end boards.

Design litters or berths intended for adults for occupants weighing at least 170 lbs. In those instances where litters or berths are for children, design the installation for the maximum intended weight. See paragraph 247 for placarding.

Provide approved seats for any cabin attendants or other passengers that will be carried when litters are installed.

b. Cargo tiedown devices may be assembled from webbing, nets, rope, cables, fittings, or other material which conforms to NAS, TSO, AN, MIL-SPEC, or other acceptable standards. Use snaps, hooks, clamps, buckles, or other acceptable fasteners rather than relying upon knots for securing cargo. Install tensioning devices or other means to provide a method of tightening and adjusting the restraint system to fit the cargoes to be carried.

Provide covers or guards where necessary to prevent damage to or jamming of the aircraft's equipment, structure, or control cables.

244. STRUCTURAL ATTACHMENT. Commercially available seat tracks, rails, or other types of anchor plates may be used for structural attachment, provided they conform to an accepted standard (see chapter 1, paragraph 6). This type of hardware permits a ready means of mounting a wide variety of quick-disconnect fittings for litters, berths, and cargo tiedown. Typical examples of such fittings and their attachment are shown in figures 12.1 through 12.5.

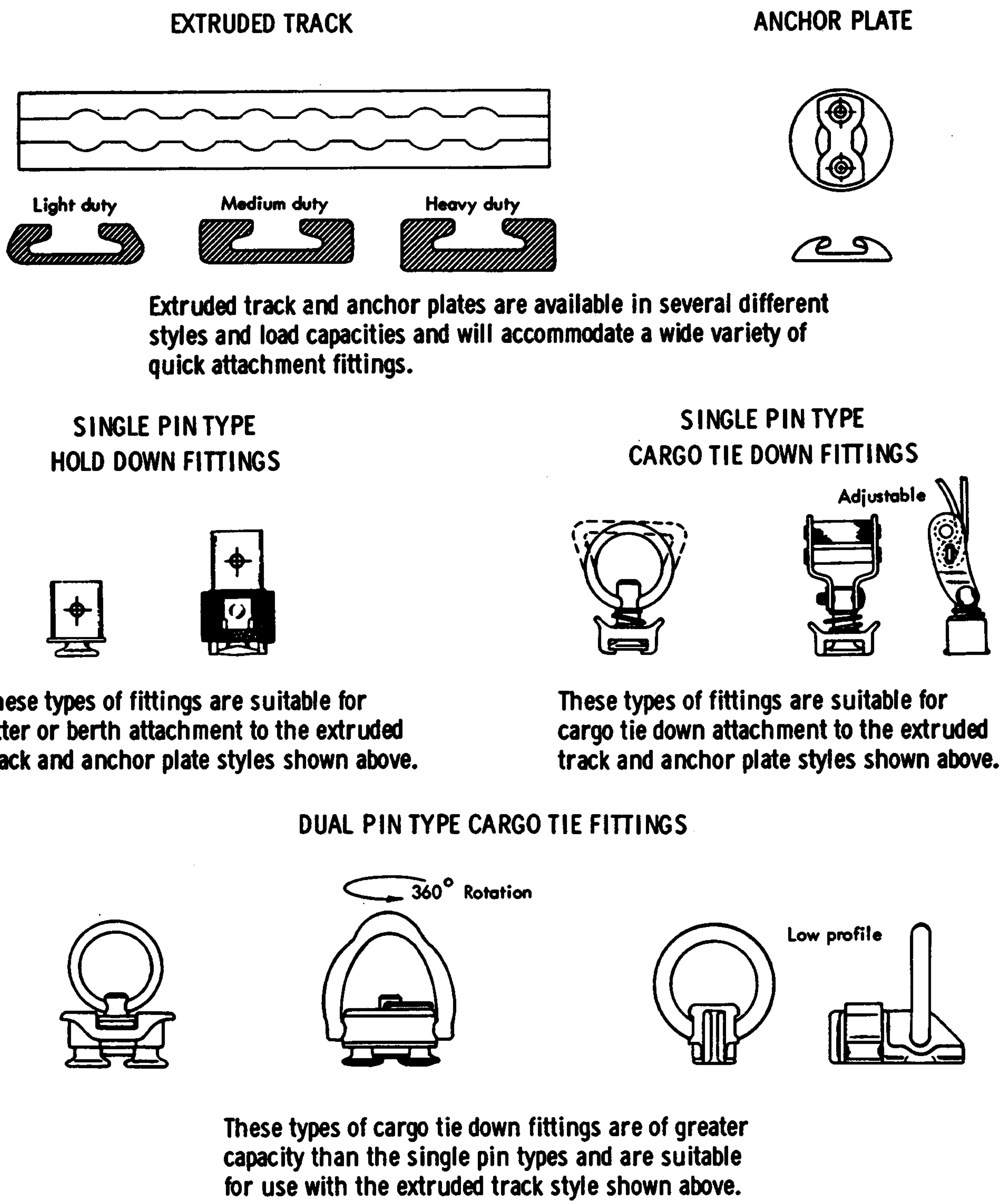


FIGURE 12.1. Extruded track, anchor plates, and associated fittings.

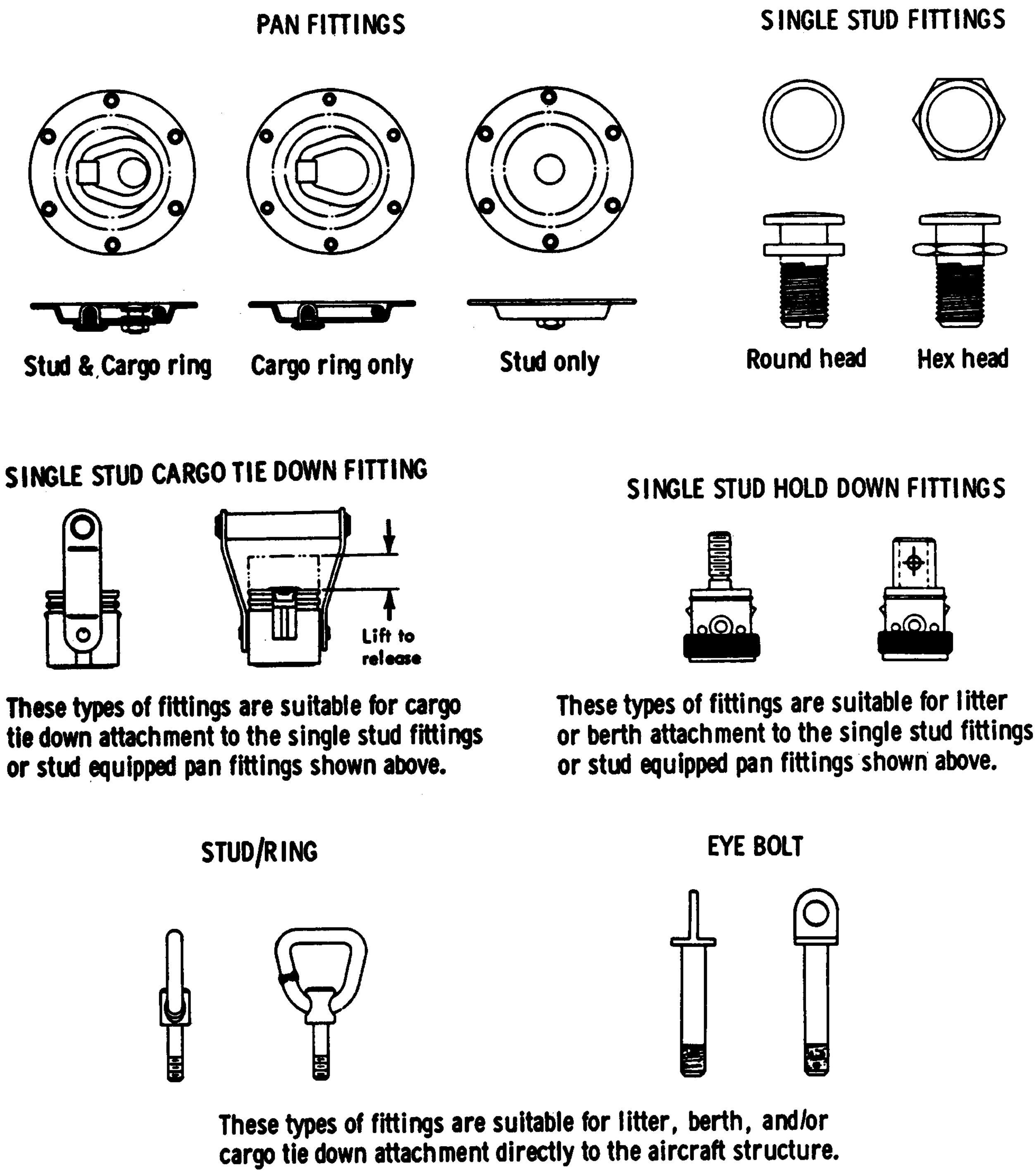
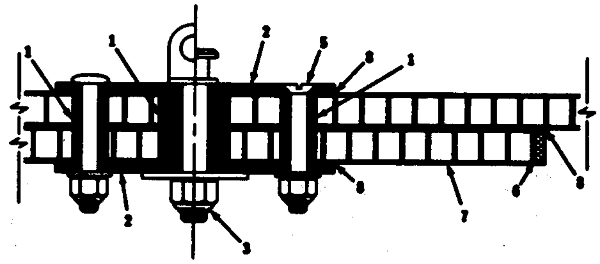
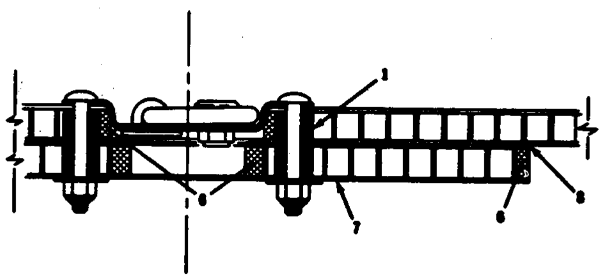


FIGURE 12.2. Miscellaneous litter, berth, and cargo tiedown fittings.

A. Attachment method utilizing a honeycomb doubler.

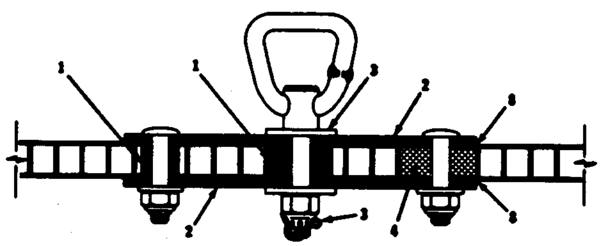


Single Studs or Eye Bolts.



Pan Fittings.

B. Attachment methods utilizing reinforcing plates.



Stud/Rings.

1. Bed all inserts and spacers in a suitable potting compound.
2. Reinforcing plate.
3. Where fitting is subject to rotation, place washers on both sides and use a positive safety means.
4. (Alternate method in lieu of spacers) Undercut honeycomb, inject potting compound, and drill through when set.
5. Countersink if required for clearance or if desired for appearance.
6. Undercut all open edges of honeycomb 1/16″ and seal with potting compound.
7. Honeycomb doubler.
8. Use epoxy or other suitable adhesive to attach doubler and reinforcing plates.

FIGURE 12.3. Typical attachment of fittings to honeycomb structures.

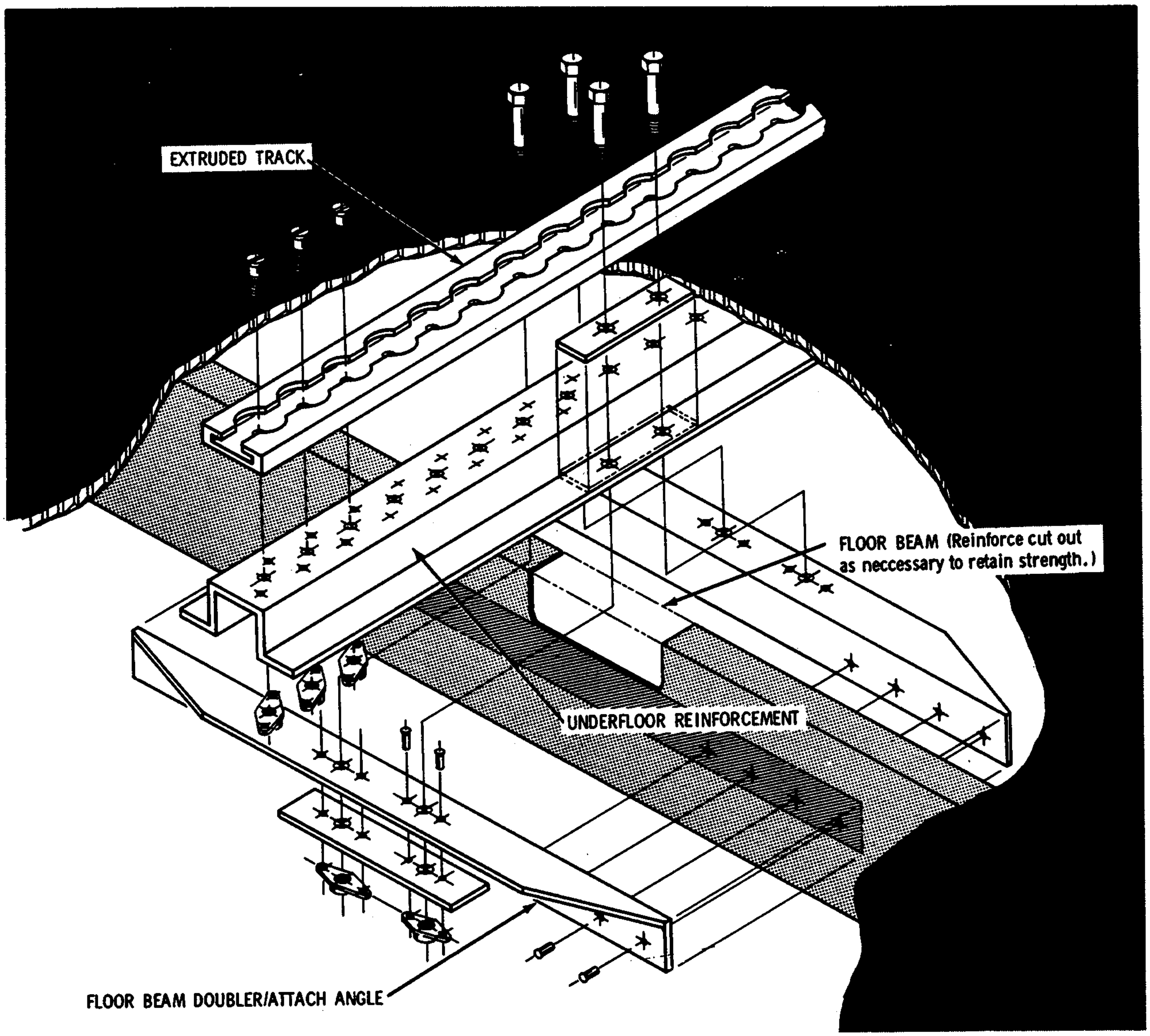
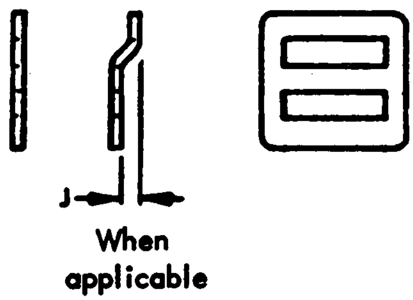


FIGURE 12.4. Installation of underfloor support for extruded track.

THREE BAR TYPE SLIDE



Rigging for easiest adjustment and moderate loads.

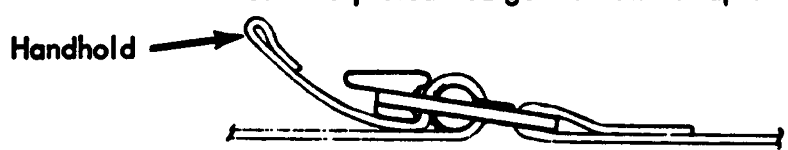
Rigging for maximum load whether slide is joggled or not.

TYPICAL NAS STRAP ASSEMBLY

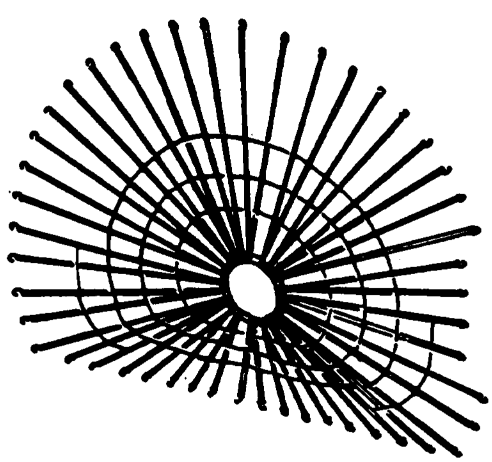
Available with various types of end hardware and up to 5000# capacity.

TENSIONING SLIDE

Used to preload cargo tie down straps.



CARGO BARRIER NET



CARGO TIE DOWN NET

Commonly used to restrain bulky or composite cargo.

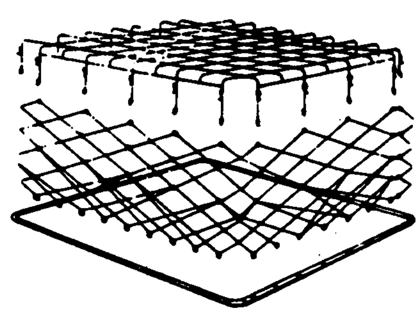


FIGURE 12.5. Typical cargo tiedown straps and cargo nets.

When installing these fittings, reinforce the existing floorboards and/or other adjacent structure to obtain the necessary load carrying capacity. Seat tracks installed longitudinally across lateral floor beams generally require full length support for adequate strength and rigidity between beam attach points (see fig. 12.4).

Consider the inherent flexibility of the aircraft structure and install any reinforcement in a manner that will avoid localized stress concentrations in the structural members/areas. Give specific attention to the size, shape, and thickness of the reinforcement, fastener size and pattern, and the effects of any adhesives used.

Fittings used for litter, berth, safety belt, and/or cargo tiedown attachment need not be substantiated by static tests if it can be shown that the fitting's rated minimum breaking strength would not be exceeded by the applicable static test loads. Existing racks, rails, or other points used for attachment may be verified by static tests, analysis, or a written statement by the aircraft manufacturer attesting to its adequacy to withstand the necessary loads.

For litters which are to be readily installed and removed, it may be desirable to utilize existing seat structure, safety belt attach fittings, seat tracks, or other seat attach fittings. When using such attach points, assure by static tests or manufacturer's written statement that they will not be stressed beyond the loads for which they were originally intended.

245. LOAD FACTORS. Use the load factor established by the aircraft manufacturer for type certification as the basis for substantiating the litter or berth and its attachment to the aircraft structure. Cargo tiedown devices installed within passenger compartments are subject to the same load factors as litter or berth installations. Refer to the applicable operating rules for any additional load factor requirements if the aircraft is to be used for air taxi or other commercial operations.

The critical load factors to which the installation is to be substantiated are generally available from the person currently holding the aircraft's Type Certificate (T.C.). When the T.C. holder is no longer active, such data may be obtained from the controlling FAA regional engineering office. The addresses of T.C. holders and FAA controlling regions are given in the FAA publication "Type Certificate Data Sheets and Specifications."

246. STATIC TESTS. It is recommended that static testing be conducted on a duplicate installation in a jig or mockup which simulates the related aircraft structure. Refer to chapter 1, paragraph 3 for static test information.

If the actual installation is used for static testing, inspect both the aircraft and the litter, berth, or cargo tiedown device installation thoroughly before releasing to service. Check all members and fittings for cracks, distortion, wrinkles, or elongated holes. Replace all bolts and threaded fittings that are not inspected by magnetic particle or other acceptable N.D.T. inspection process. Inspect riveted joints for tipped rivet heads and other indications of partially sheared rivets or elongated holes.

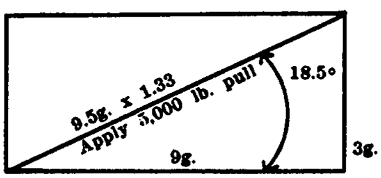
a. For litter and berth installations, compute the up, down, side, fore, and aft static test loads required for substantiation by multiplying the standard passenger weight, 170 lb., by each of the *critical static test load factors*. Refer to chapter 1 of this handbook for computation procedures. (For utility category aircraft use 190 lb., and for litters or berths intended for children use the placarded weight.) Perform tests as necessary to substantiate the complete litter or berth installation for each intended position (forward, aft, or side-facing). When testing for a particular load, install or adjust the litter or berth to the most critical position for that load.

When the safety belt or harness and/or the padded end board is attached to the litter or berth structure, all loads are to be borne by the litter or berth structure and its attachment fittings. Where these are not attached to the litter or berth structure, substantiate the total litter or berth installation for the loads which would be imposed for that safety belt attachment/end board configuration.

b. Cargo Tiedown Installations. All cargo tiedown installations must be tested to the critical ultimate load factor. Refer to chapter 1 of this handbook for computation and testing procedures.

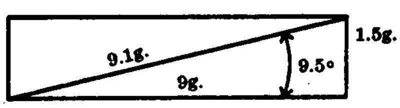
When the cargo compartment is separated from the cockpit by a bulkhead that is capable of withstanding the inertia forces of emergency conditions a forward load factor of 4.5g. may be used. All other applications require the use of a 9g. forward load factor.

Each cargo tiedown fitting installation must be static tested under forward, side, and up load conditions. Individual fittings may be tested by applying a single pull of 12.6g. forward load at an angle of 18.5° up and 9.5° to the left or right, as applicable, of the aircraft longitudinal axis. For example, assuming a 5,000 pound static pull (rating of a typical tiedown fitting) is applied as described and divided by the g. load factor we find the fitting installation will be capable of restraining a 397 pound load under emergency conditions.



$$9.5g. \times 1.33 = 12.6g.$$

$$\frac{5{,}000 \text{ lb.}}{12.6g.} = 397 \text{ lb.}$$



When a cargo-restraining net or cargo container with multiple attachments is used the static load requirements for each tiedown fitting may be divided equally between the fittings. For example, assume that the maximum cargo load to be carried is 1,800 pounds and 10 tiedown fittings are to be used, the static load requirement for each fitting is approximately 2,155 lbs.

$$\frac{9g. \times 1.33 \times 1{,}800 \text{ lbs.}}{10 \text{ fittings}} = 2154.6 \text{ lbs.}$$

Placard individual tiedowns for the maximum weight to be secured.

247. OPERATING LIMITATIONS, LOADING INSTRUCTIONS, AND PLACARDS. Prepare revisions or supplements to the aircraft's Flight Manual or operating limitations, weight and balance records, and equipment list changes as necessitated by the installation of the litter, berth, or cargo tiedown systems.

NOTE.—Revisions or supplements to the approved portions of the aircraft's Flight Manual markings, placards, or other operating limitations require FAA engineering approval. Submit the requested changes and supporting data to the local FAA Flight Standards Office for review and processing.

Provide instructions covering the installation and use of the litter or cargo restraint systems. For aircraft which require a Flight Manual, incorporate these instructions as a supplement. On other aircraft, provide a placard which references the appropriate instruction. In the instructions, cover such items as removal and reinstallation of seats or other equipment exchanged for litters or cargo restraint systems, use of cargo nets, barrier nets, number and positioning of tiedown straps, maximum load for each compartment or tiedown area, permissible load per square foot, number of tiedown points allowable per foot of track, and maximum height of the load's center of gravity above the floor.

a. Cargo Area Placards. Install placards or other permanent markings to indicate the maximum allowable cargo load and weight per square foot limitation for each cargo area. Placard seat tracks as to number of tiedown points permissible per foot of track. Attach a permanent lable or other marking on each cargo net, barrier net, and at cargo tiedowns to indicate the maximum cargo weight that the net or attachment will restrain when installed according to the loading instructions.

b. Litter and Berth Placards. Install a placard or other permanent marking on each litter or berth indicating its permissible direction of installation (forward, aft, or side-facing), passenger weight limitation (if less than 170 lbs.), and whether or not the litter or berth may be occupied during takeoffs and landings.

248.–260. [RESERVED]

Chapter. 13. PENETRATION THROUGH PRESSURIZED STRUCTURE

Section 1. ELECTRICAL WIRE BUNDLES AND COAXIAL CABLE FEED THROUGH PRESSURIZED STRUCTURE

261. GENERAL. This section describes typical methods for sealing openings where wires and coaxial cable are installed through pressurized structure.

a. Assure that the strength of the structure is maintained when installations require additional opening.

b. The aircraft manufacturer's data may specify the size and location where additional openings are permitted and the reinforcement required to maintain the design strength of the affected area.

c. The manufacturer's data may also recommend the specific sealant to be used and provide instructions for the application.

> **Caution:** Sealant and solvents may contain toxic and/or flammable components. Avoid inhalation of vapors and supply adequate ventilation. Wear appropriate respiratory protection while using these materials in confined areas. Avoid contact with the skin and eye.

262. CLEANING. Use a cleaning solvent and clean a larger area than required for the fair-lead or connector. Remove solvent by blasting with dry air and wiping with a clean soft cloth.

263. APPLICATION OF SEALANT. Seal electrical wire bundles and connectors where they pass through the opening in the pressurized structure.

a. Separate and coat each wire with sealant over the length which is to pass through the fair-lead, fig. 13.1A. After coating each wire with sealant, pull the wire bundle into position in the fair-lead, fig. 13.1B. Assure that the fair-lead is located on the pressure side of the structure.

b. Apply sealant to the surface of the fair-lead which comes in contact with the pressurized structure. Use a spatula or brush and spread sealant on the entire surface approximately $\frac{1}{32}$-inch in thickness. Attach the fair-lead to the pressurized structure, sealant, sealant should extrude around the mounting flange (see fig. 13.1C).

c. Wrap the fair-lead with at least three turns of masking tape as shown in fig. 13.1D. Puncture the masking tape over the injection hole in the fair-lead assembly and inject sealant with a sealing gun. Apply sealant over each fair-lead fastener as shown in fig. 13.1E.

d. Complete all of the aforementioned steps during the application time of the sealant. Allow sealant to cure, remove masking tape and excess sealant which extruded from the fair-lead mounting flange.

e. Figures 13.2 and 13.3 illustrate a different type fair-lead and wire bundle connector. The procedure for sealant application is the same as previously described.

f. Figure 13.4 illustrates various coaxial connectors frequently used for installation through structure. Fair-leads are not recommended for installation of coaxial cable. Sealant application is the same as previously described.

264.–290. [RESERVED]

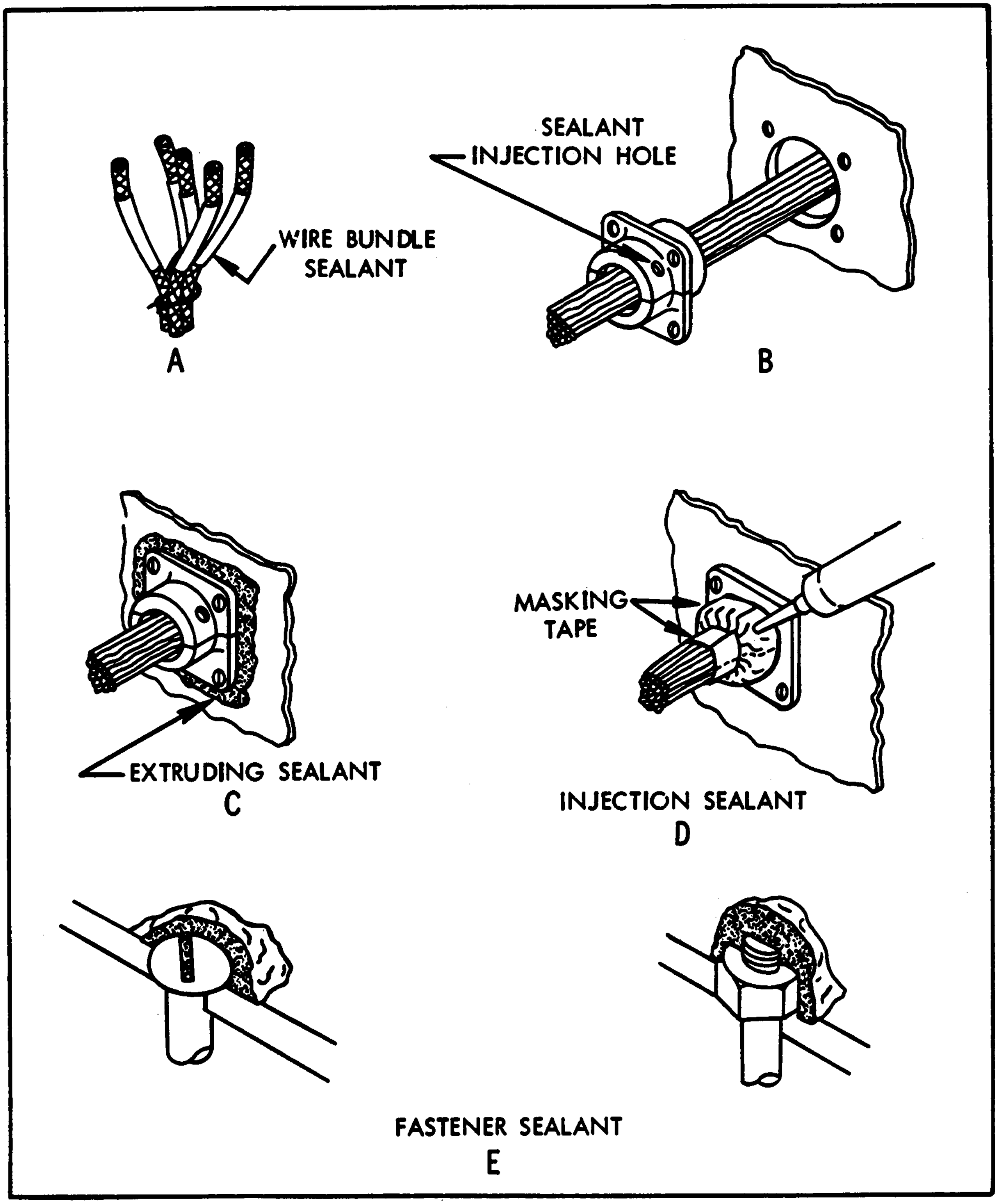


FIGURE 13.1 Sealant application.

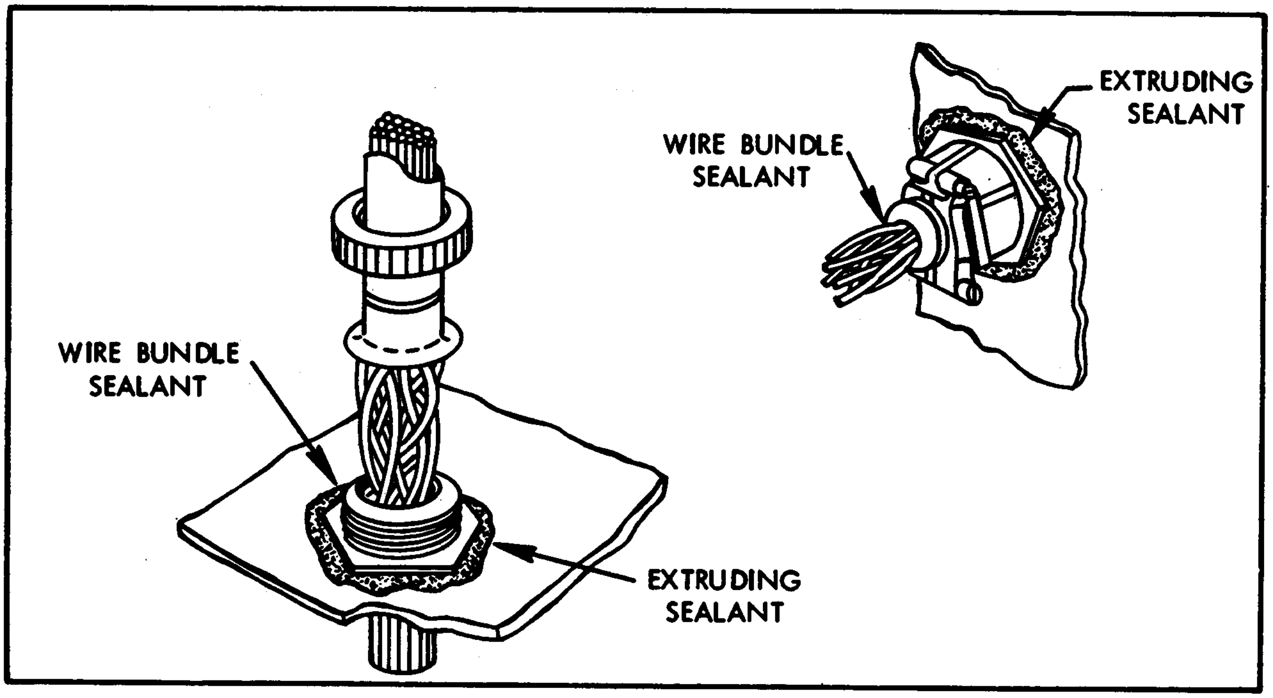


FIGURE 13.2 Fair-lead feed through.

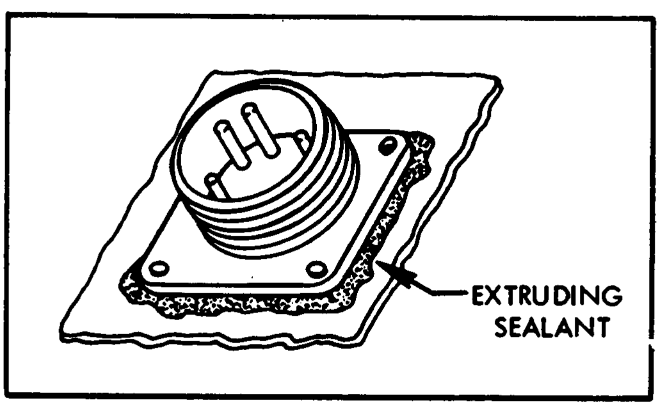


FIGURE 13.3 Typical connector.

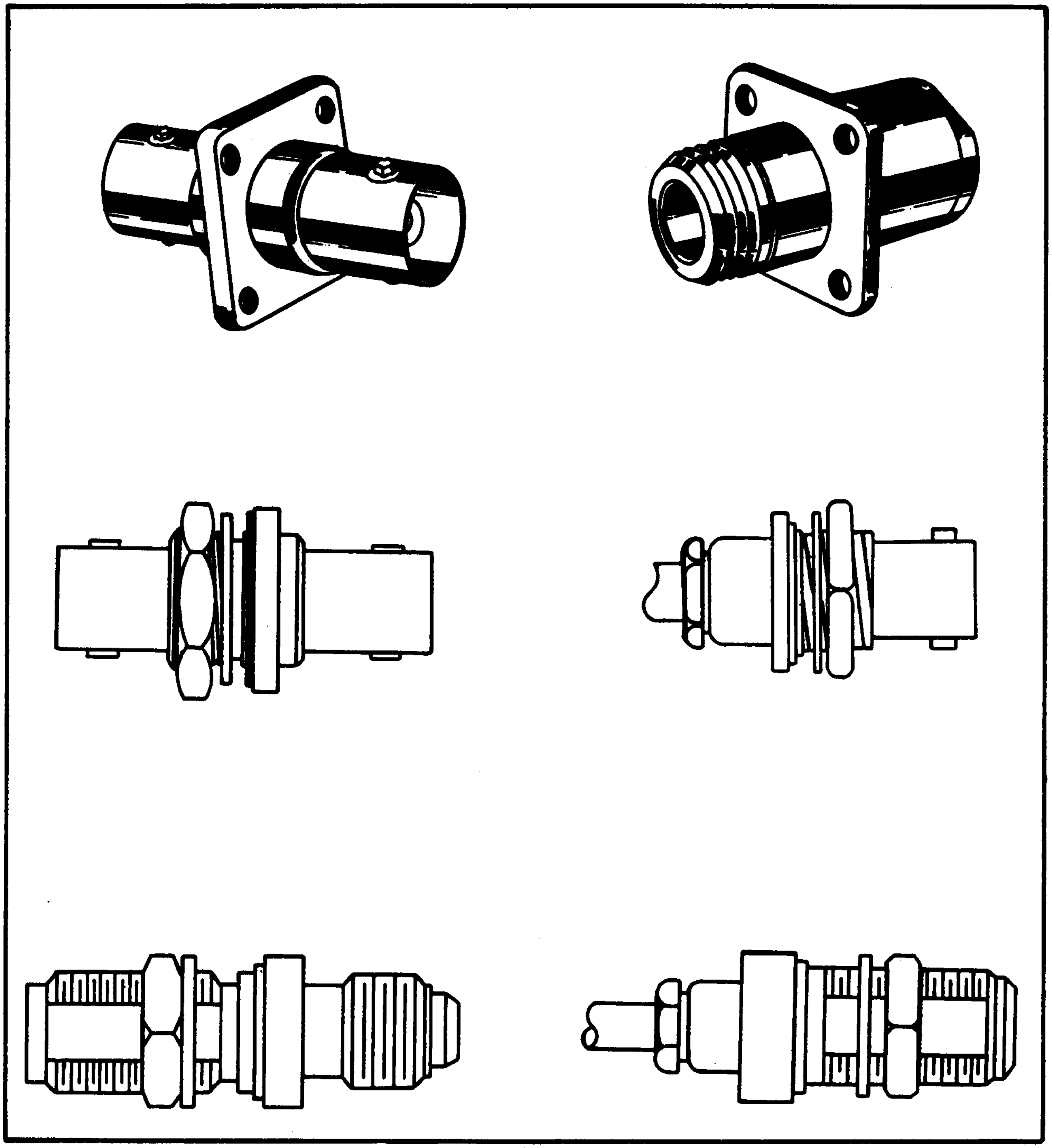


FIGURE 13.4 Coaxial connectors.

Appendix 1

CROSS REFERENCE TABLE OF PARAGRAPH NUMBER CHANGES FROM AC 43.13–2 DATED 1965

Former Paragraph	Revised Paragraph
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10	10
11	11
12	12
13–20 [Reserved]	13–20 [Reserved]
21	21
22	22
23	23
24	24
25	25
26	26
27	27
28–30 [Reserved]	28
	29–35 [Reserved]
31	36
32	37
33	38
34	39
35	40
36	41
37	42
38	43
39	44
40 [Reserved]	45–50 [Reserved]
41	51
42	52
43	53
44	54
45	55
46	56
47–50 [Reserved]	57–60 [Reserved]
51	61
52	62
53	63
54	64
	65 [Reserved]
55	66
56	67

Former Paragraph	Revised Paragraph
57	68
58	69
	70 [Reserved]
59	71
60	72
61	73
62	74
63	75
	76–78 [Reserved]
64	79
65	80
66	81
67–70 [Reserved]	82–85 [Reserved]
71	86
72	87
73	88
74	89
75	90
76	91
77–80 [Reserved]	92–95 [Reserved]
81	96
82	97
83	98
84	99
85	100
86	101
87	102
88	103
89	104
90	105
91	106
	107–110 [Reserved]
92	111
93	112
94	113
95	114
96–100 [Reserved]	115–120 [Reserved]
101	121
102	122
103	123
	124–125 [Reserved]
104	126
105	127
106	128
107	129
108	130

Former Paragraph	Revised Paragraph
109	131
110	132
111	133
112–120 [Reserved]	134–145 [Reserved]
121	146
122	147
123	148
124	149
125	150
126	151
	152–155 [Reserved]
127	156
128	157
129	158
	159–160 [Reserved]
130	161
131	162
132	163
133	164
134	165
135	166
136	167
	168–170 [Reserved]
137	171
138	172
139	173
	174–175 [Reserved]
140–150 [Reserved]	
151	176
152	177
153	178
154	179
	180–185 [Reserved]
155	186
156	187
157	188
158	189
	190–195 [Reserved]
159	196
160	197
161	198
162	199
163	200
164	201
165	202
	203
166–180 [Reserved]	204
	205
	206
	207–210 [Reserved]
181	211
182	212
183	213
184	214
185–199 [Reserved]	215–240 [Reserved]
200 [Reserved]	
201	241
202	242
203	243
204	244
205	245
206	246
207	247
208–230 [Reserved]	248–260 [Reserved]
231	261
232	262
233	263
234–260	264–290 [Reserved]

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